FINAL REPORT

APRIL 1989

REPORT NO. EVT 15-89

ENGINEERING TEST OF POWER DRIVEN NAILS

Prepared for:

U.S. Army Armament, Research, Development and Engineering Center
ATTN: SMCAR-ESK
Rock Islands, IL 61299-7300

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US ARMY DEFENSE AMMUNITION
CENTER AND SCHOOL

EVALUATION DIVISION
SAVANNA, ILLINOIS 61074-9639

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV), has been tasked by the U.S. Army Armament, Munitions and Chemical Command (SMCAR-ESK), Rock Islands, IL, to evaluate an Engineering Change Proposal (ECP) which requested the addition of a cooler nail and a box-style nail to the unitization procedures developed by the Storage and Outloading Division (SMCAC-DEO). In order to evaluate the performance of the additional nails, a comparison was performed to measure the holding strengths of common, cooler, and annular-ring cooler nails in the dynamic shear mode. Tests were not conducted on the box style nail because the nail would be used in clinching applications which do not experience any stresses.

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19. Continued

The results from the dynamic testing indicate that the cooler nail, which is shorter and has a smaller diameter than the corresponding common nail, has a smaller holding strength than the common nail. The relationship between the holding strengths of the common and cooler nail appears to be proportional to the relationship of the holding surface area of the common nail versus the holding surface area of the cooler nail. The results also showed that the annular-ring cooler nail provides a larger holding strength than the corresponding common nail.

U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
Evaluation Division
Savanna, IL 61074-9639

REPORT NO. EVT 15-89
ENGINEERING TEST OF POWER DRIVEN NAILS

TABLE OF CONTENTS

PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division, was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-ESK, to evaluate an Engineering Change Proposal (ECP) which would add two additional types of nails to the unitization procedures developed by the Storage and Outloading Division, SMCAC-DEO. The two nails that were stated in the ECP were a cooler nail with blunt point and bright finish and a box-style nail for clinching applications. (See Fed-Spec FF-N-105) After discussion with the originators of the ECP, the actual type of cooler nail that the contractor wanted added to the list was a cooler nail with annular rings. Testing was conducted on the cooler nails both with and without annular rings. Testing was not conducted on the box-style nails because clinching applications are not subjected to stresses.

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL.

C. OBJECTIVE. The objective of these tests was to assess the capability of the cooler nails to be substituted for the common nails currently specified in the unitization drawings.

PART 2

ATTENDEES

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Sandra Schultz Industrial Engineer	U.S. Army Defense Ammunition Center and School ATTN: SMCAC-DEO Savanna, IL 61074-9639 AV 585-8086
William Frerichs Chief, Storage & Outloading Division	U.S. Army Defense Ammunition Center and School ATTN: SMCAC-DEO Savanna, IL 61074-9639 AV 585-8071

PART 3

TEST PROCEDURES

The test procedures to measure the peak force at which the nail joints shear involved constructing six wood/nail joints for each size and type of nail. Each wood/nail joint consisted of one section of pine 4" x 4", one section of oak 5/8" x 3", and two nails. (See Figure 1) While assembling, precautions were taken to prevent the hand driven

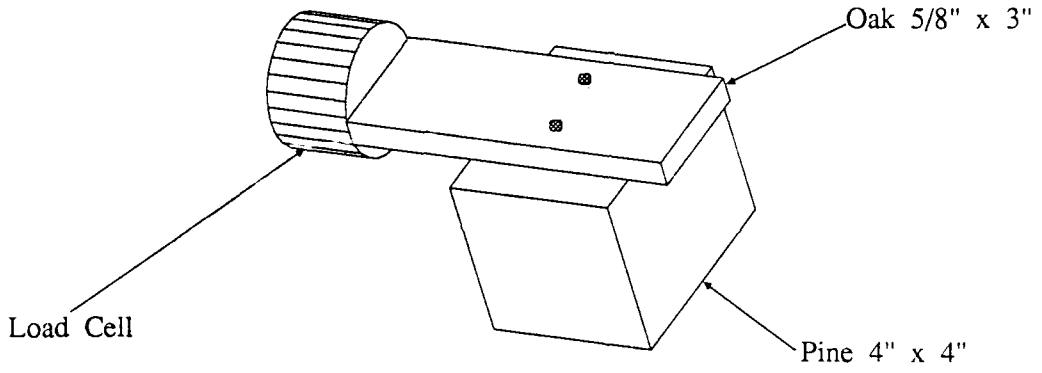


Figure 1: Test Sample Configuration

and power driven nails from being driven below the surface of the oak piece. Also, the 5/8" dimension on the oak piece of wood was strictly maintained so that the penetration of the nail into the pine 4" x 4" would be consistent between samples. Within four hours after assembly, the samples were tested one at a time in the inclined impact tester. As seen in Figure 2, the inclined impact tester travels 4 feet down the ramp and into the inclined impact surface. Prior to the time of impact, the datalogging

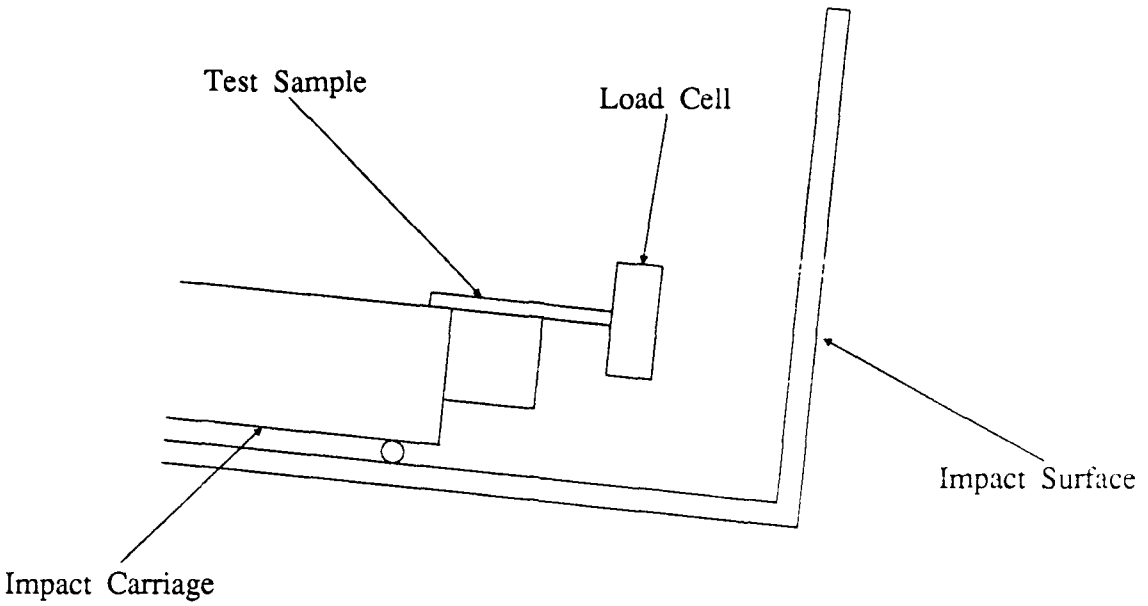


Figure 2: Testing Apparatus

device was activated so that the load cell which was attached to the front of the wood/nail joint would record the forces that were being experienced. After impact, the old wood/nail joint was removed and a new wood/nail joint was installed. This process was repeated until all the samples had been tested. During the testing, any samples that did not shear cleanly (both nails pulled from the pine 4" x 4" without the oak piece cracking), or had nails that failed, were retested using new nails and wood. After completion of the testing, the datalogger was downloaded into an IBM-AT compatible computer where the data could be analyzed.

PART 4

TEST EQUIPMENT

1. TEST SPECIMENS:
   a. 6d Cooler (1-7/8" x .099") Power Driven
   b. 8d Cooler (2-3/8" x .113") Power Driven
   c. 10d Cooler (2-3/4" x .120") Power Driven
   d. 6d Annular-Ring Cooler (1-7/8" x .099") Power Driven
   e. 8d Annular-Ring Cooler (2-3/8" x .113") Power Driven
   f. Unavailable: 10d Annular-Ring Cooler (2-3/4" x .120") Power Driven
   g. 6d Common (2" x .120") Hand Driven
   h. 8d Common (2-1/2" x .148") Hand Driven
   i. 10d Common (3" x .120") Hand Driven

2. POWER NAILER:

a. Manufacturer:	Paslode
b. Model:	5300+
c. Nail Range:	1-7/8" to 2-3/4"

3. DATALOGGER:

a. Manufacturer:	OmniData International
b. Sampling Speed:	1024 Points/Second
c. Filtering:	None

4. INCLINED RAMP:

a. Manufacturer:	Conbur Incline
b. Type:	Impact Tester
c. Grade:	10 percent Incline
d. Impact Travel:	4-foot

PART 5

TEST RESULTS

Once downloaded into the computer, the data was analyzed using a spreadsheet program. The first step in analyzing the data was to determine the peak force at which the wood/nail joint failed. As seen in Table 1, the peak values for each of the six samples for each nail type and size are listed.

Table 1: Peak Values in Pounds Measured by Load Cell

Common

6d	8d	10d
687	972	1091
687	1016	1091
628	957	1031
732	942	1076
732	911	1151
762	926	1330

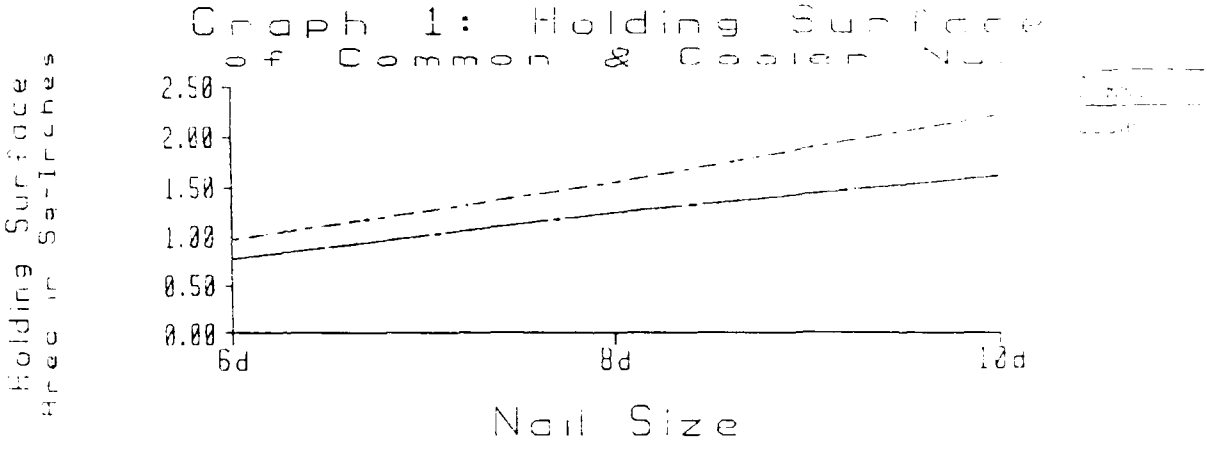
Cooler

6d	8d	10d
567	867	957
687	747	1016
597	852	1121
613	792	942
552	852	1001
538	867	867

Annular-Ring Cooler

6d	8d
747	1031
881	1181
822	957
778	1046
702	987
732	1151

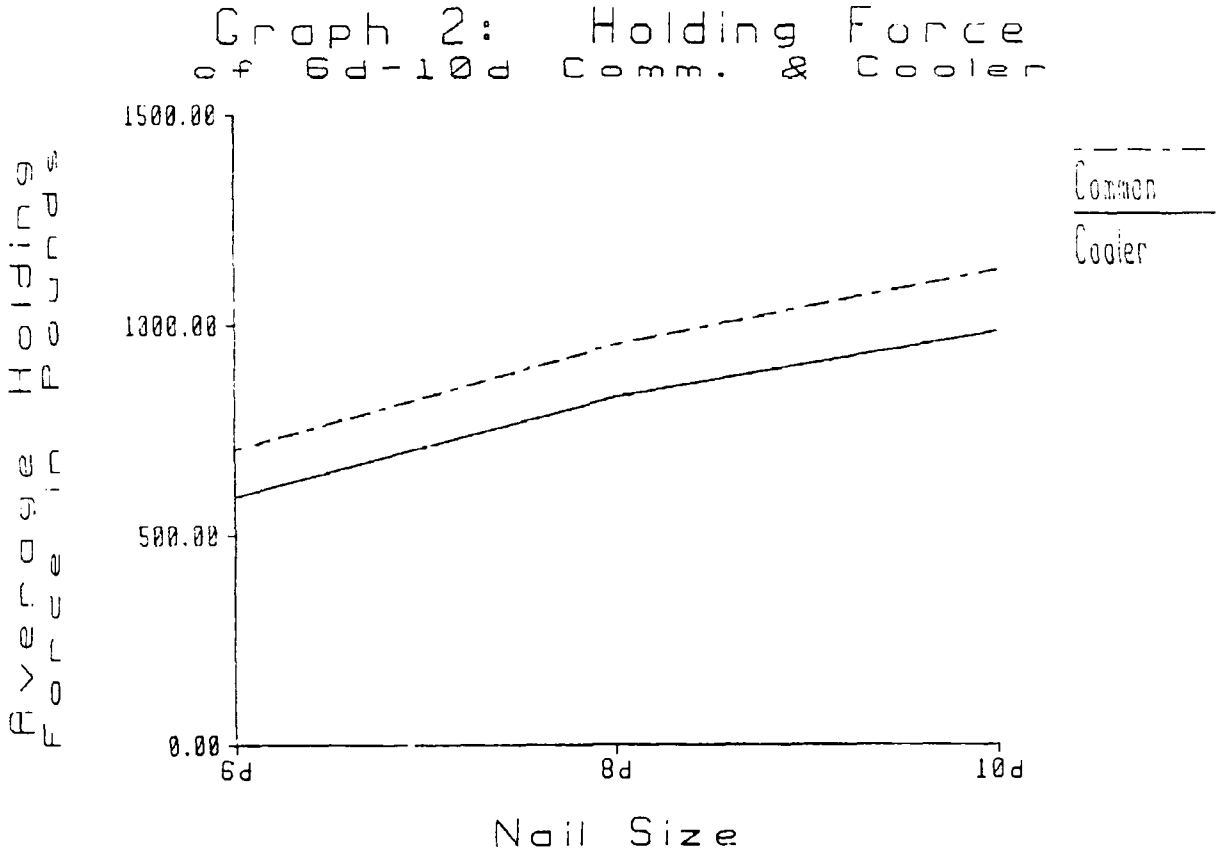
Also, a graph for each sample was produced to verify that the datalogger captured the full impact. (See PART 7) Once the peak values for each sample were determined, an average was taken for each type and size of nail so that the different types of nails could be compared. (See Table 2) In addition, the total surface area and the holding surface area of the different types of nails was calculated. From the calculated holding surface areas, a graph was developed that showed the differences in the holding surface for each of the common and cooler nail sizes. (See Graph 1). As can be seen on



Graphs 1 and 2, the peak shearing force and the holding surface graphs have similar shapes. This similarity in graphs would indicate that an equivalent holding surface area of nail in wood/nail joints would yield equivalent holding strengths.

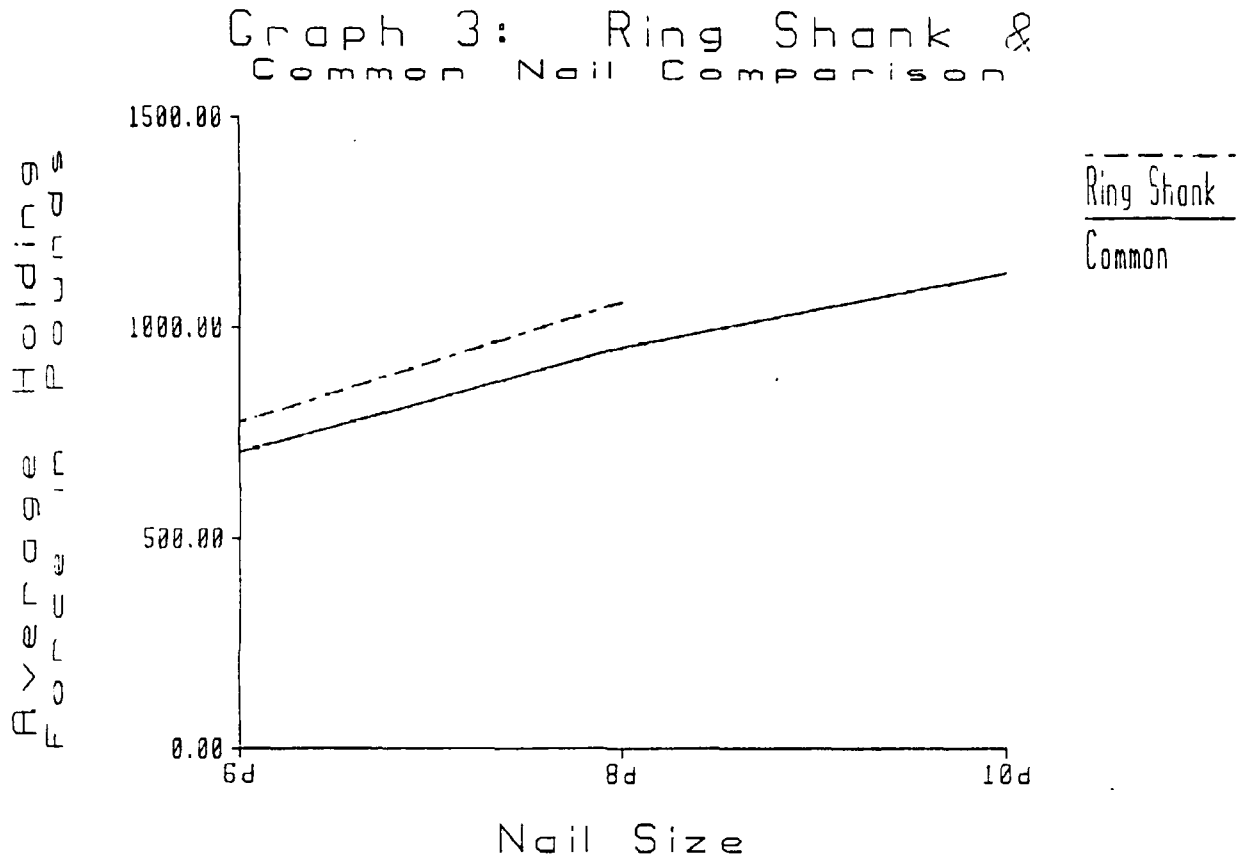
Table 2: Results from the Power Driven Nail Study

Type	Size	Diameter Inches	Length Inches	Total Surface Inches^2	Holding Surface Inches^2	Average Strength Pounds
Common	6d	0.113	2.000	1.420	0.976	705
Common	8d	0.131	2.500	2.058	1.543	954
Common	10d	0.148	3.000	2.790	2.209	1128
Cooler	6d	0.099	1.875	1.166	0.778	592
Cooler	8d	0.113	2.375	1.686	1.242	830
Cooler	10d	0.120	2.750	2.073	1.602	984
Ring Shank	6d	0.099	1.875	1.166	0.778	777
Ring Shank	8d	0.113	2.375	1.686	1.242	1059



The final step in analyzing the data was to compare the common nails and the annular-ring cooler nails. A similar comparison was not conducted between the holding surface areas of the common and annular-ring nails because of the differences in nail

geometry. As can be seen on graph 3, the annular-ring cooler nails are superior to the common nails.



PART 6

CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS. From the test results, the following conclusions can be made about the common, cooler, and annular-ring cooler nail comparison. The standard cooler nail does not provide the same amount of holding force that a common nail provides. The relationship between the standard cooler and common nails seems to indicate that an equivalent amount of surface area is required to maintain equivalent holding force. This would require using 5 cooler nails for every 6 common nails in areas where the wood/nail joint must maintain equivalent holding strength. In the annular-ring cooler nail versus common nail comparison, the test results indicate that the annular-ring cooler nail provides a greater holding strength than the common nail.

2. RECOMMENDATIONS. Since the cooler nail did not provide the equivalent holding strength as the common nail, the cooler nail should only be approved for use in the unitization drawings in a ratio of 5:6 common nail to cooler nail; i.e., 1.2 cooler nails are required for each common nail. In approving the annular-ring coolers, the annular-ring cooler provided a greater holding force and should, therefore, be approved for use in the unitization drawings in a direct ratio of 1:1 common nail to annular-ring cooler nail. Also, the box style nails should be approved for use in the clinching applications because clinching applications are not subjected to shearing forces, and the difference between box-style nails and common nails is negligible in clinching

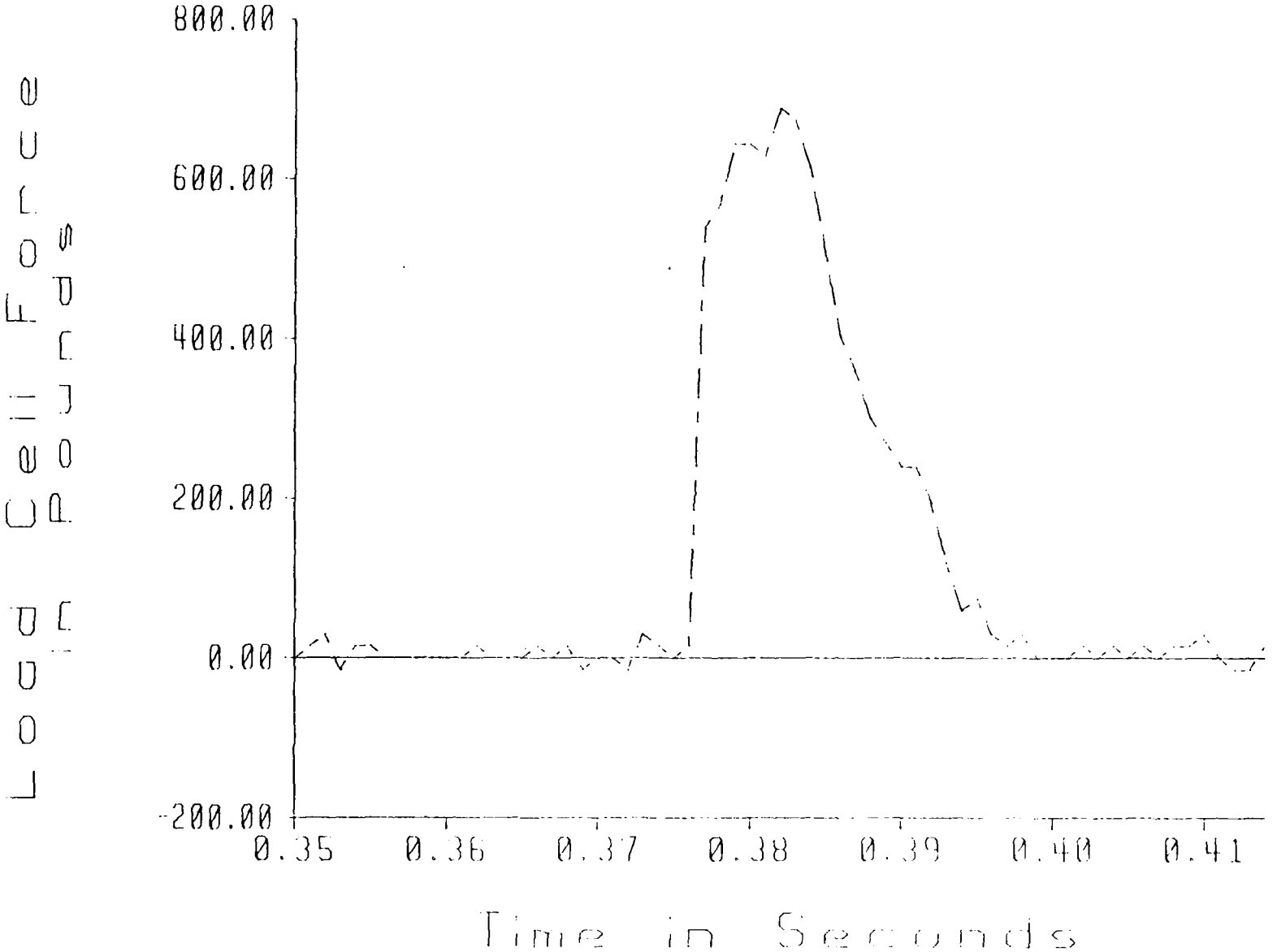
applications. (All recommendations made assuming MIL-STD FF-N-105 is strictly adhered to).

PART 7

GRAPHS

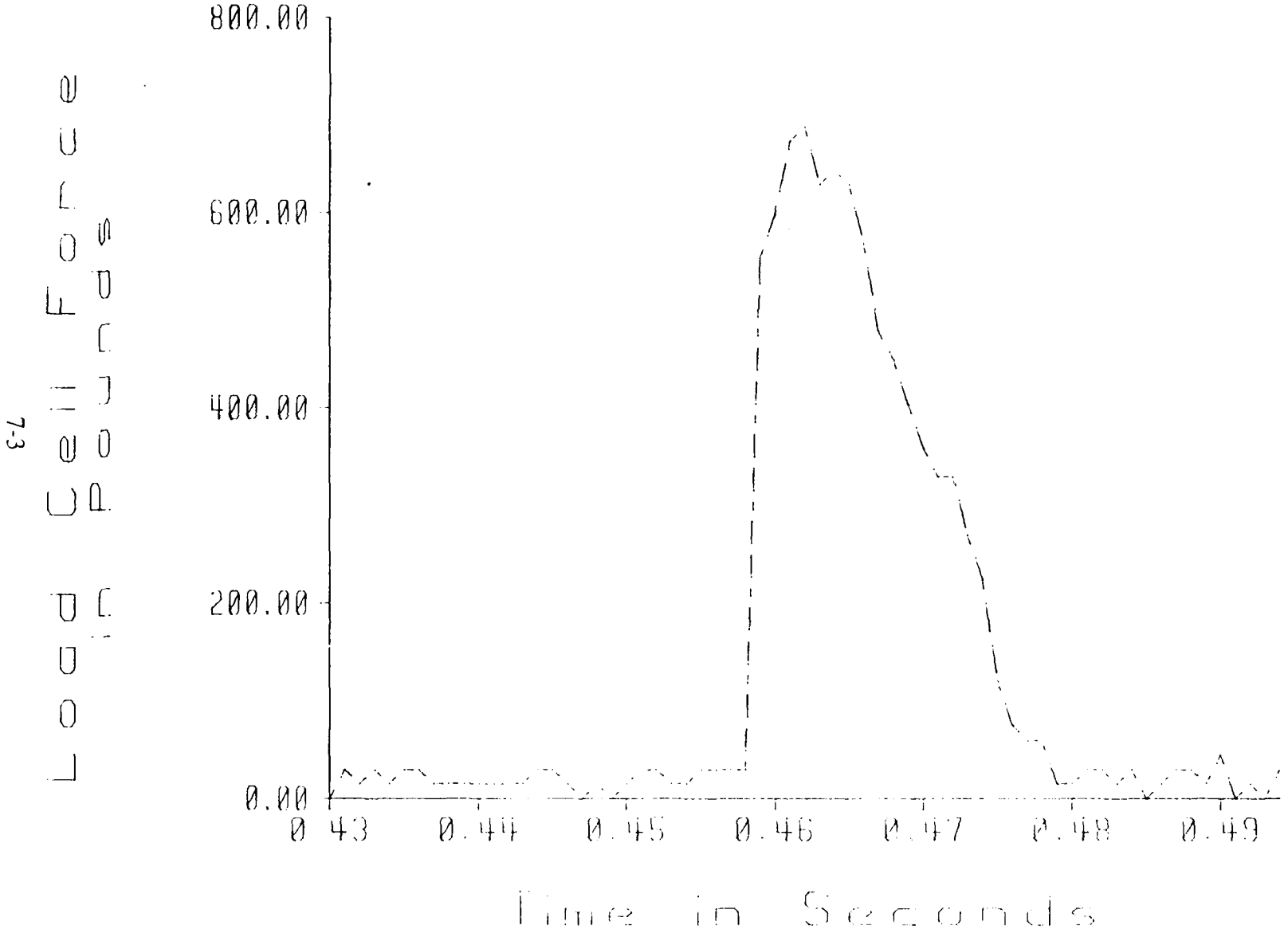
Graph 4: 6d Common Nail

Sample 1



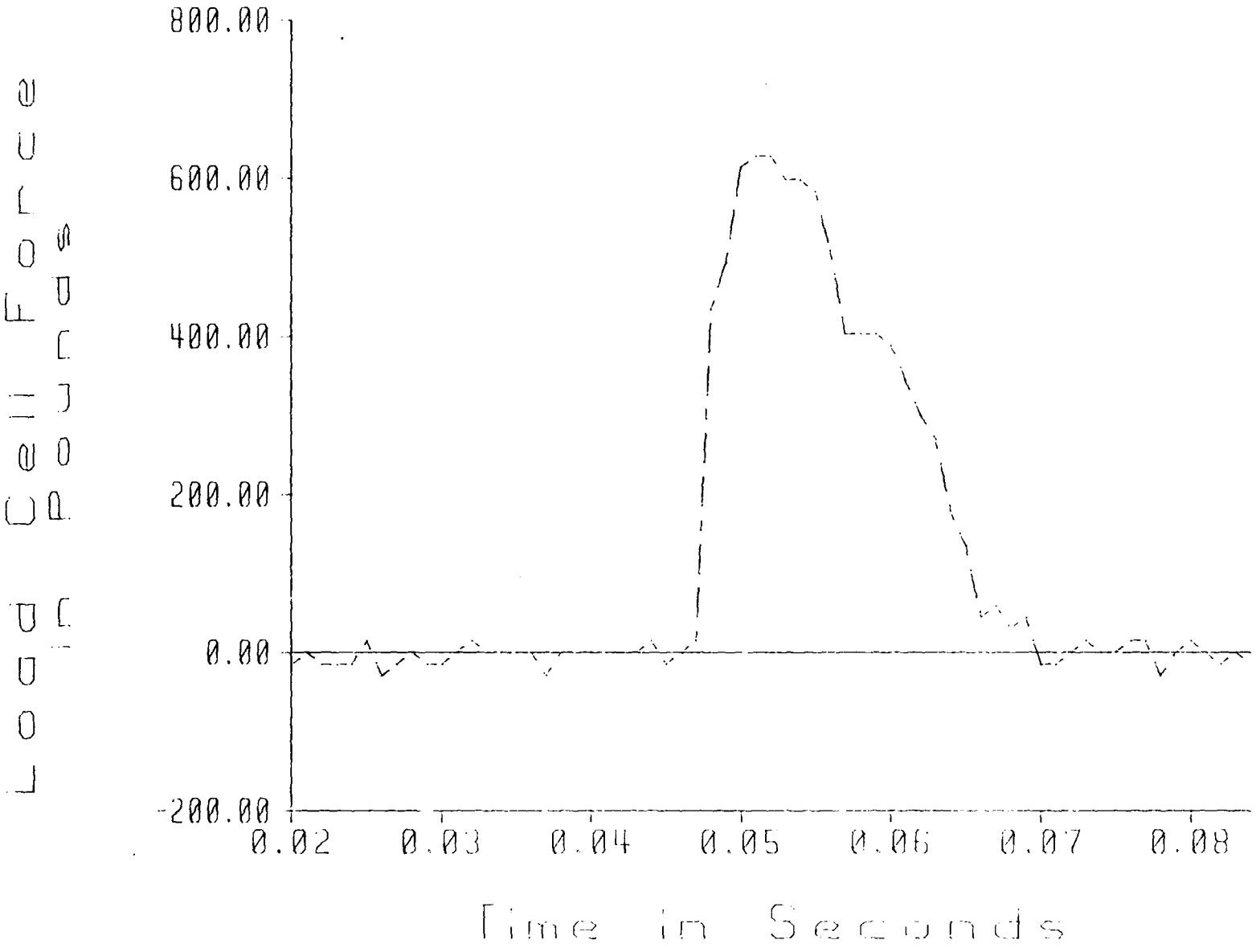
Graph 5: 6d Common Nail

Sample 2



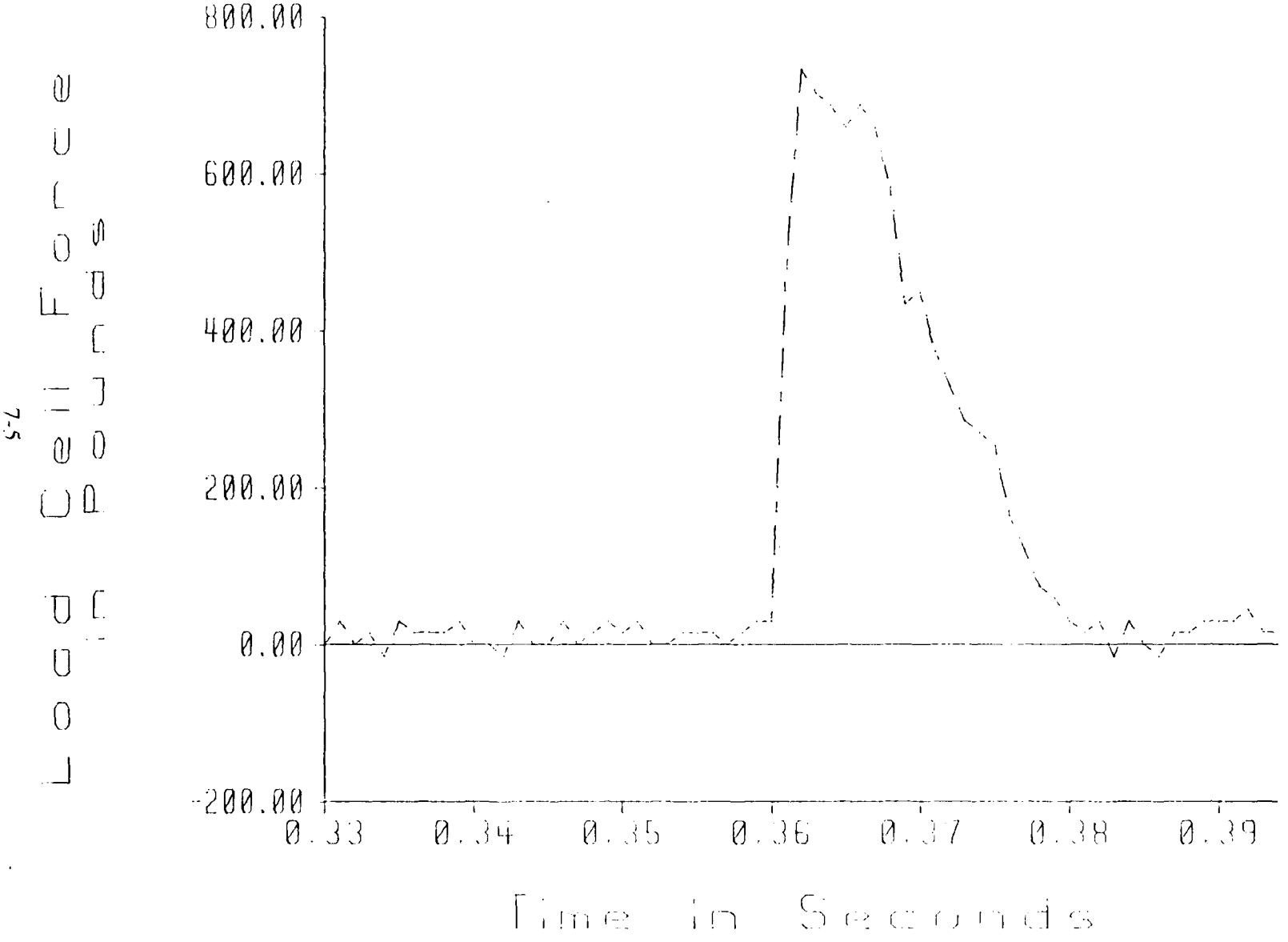
Graph 6: 6d Common Nail

Sample 3



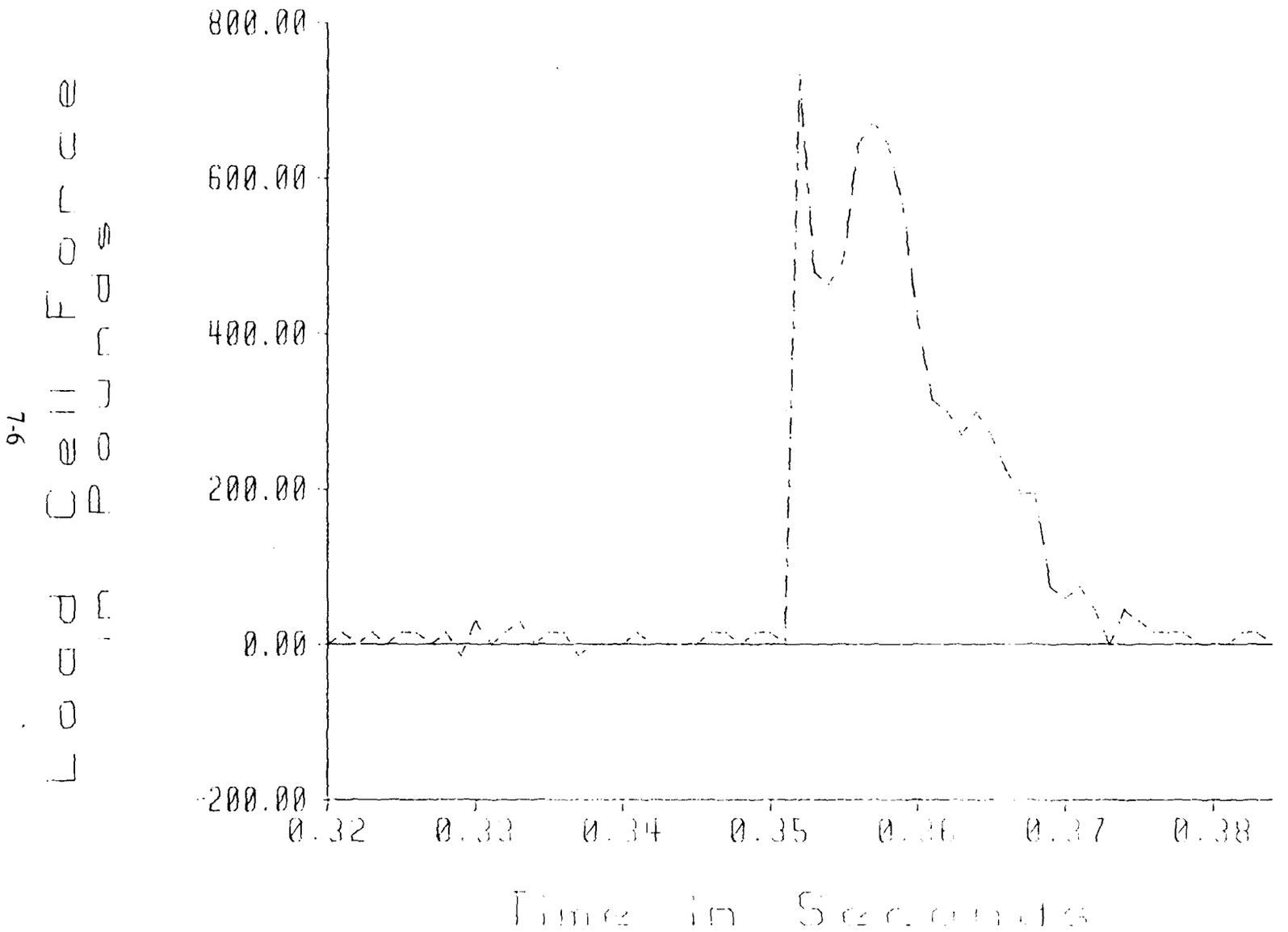
Graph 7: 6d Common Nail

Sample #4



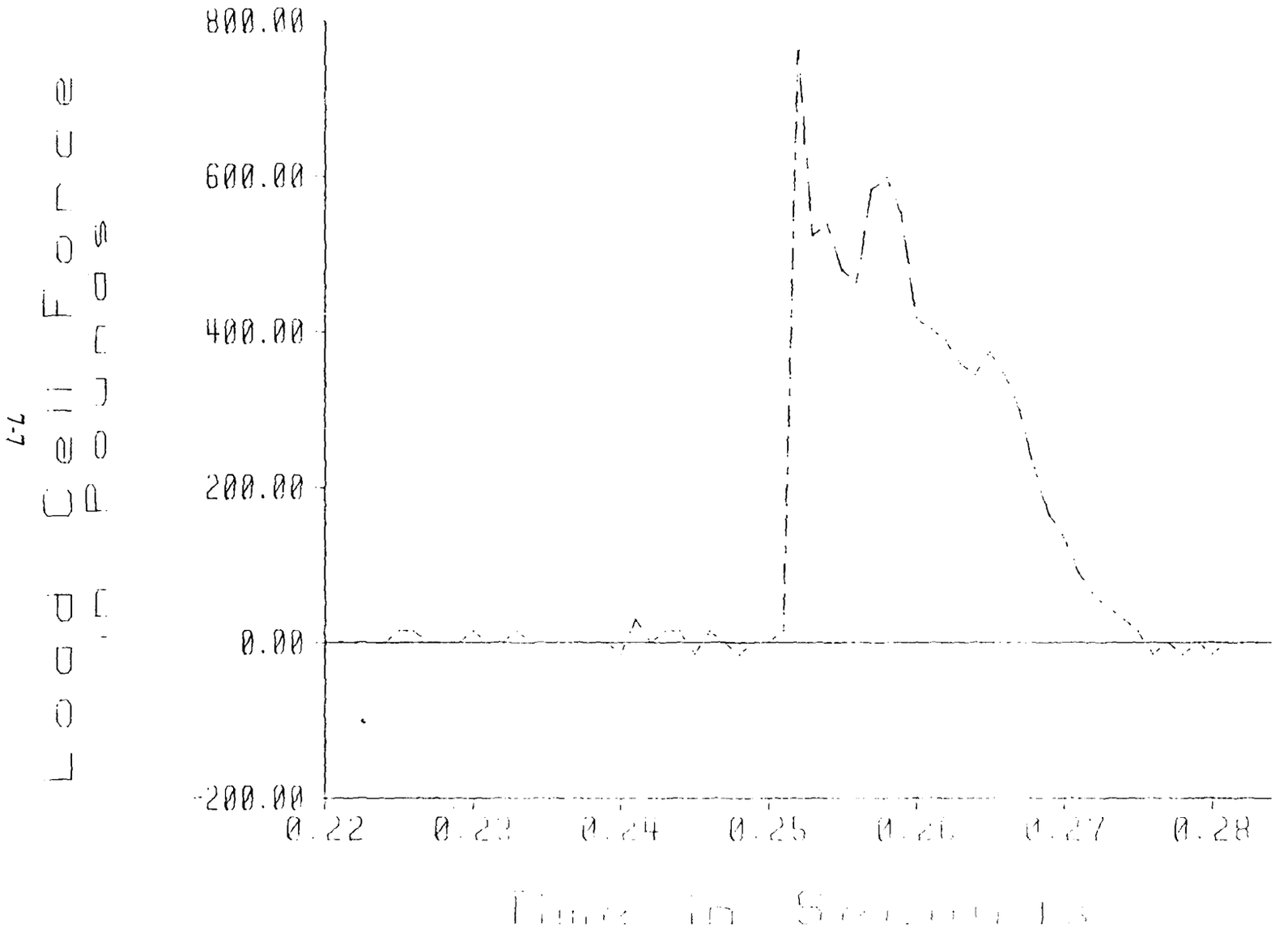
Graph 8: 6d Common Nail

Sample 5



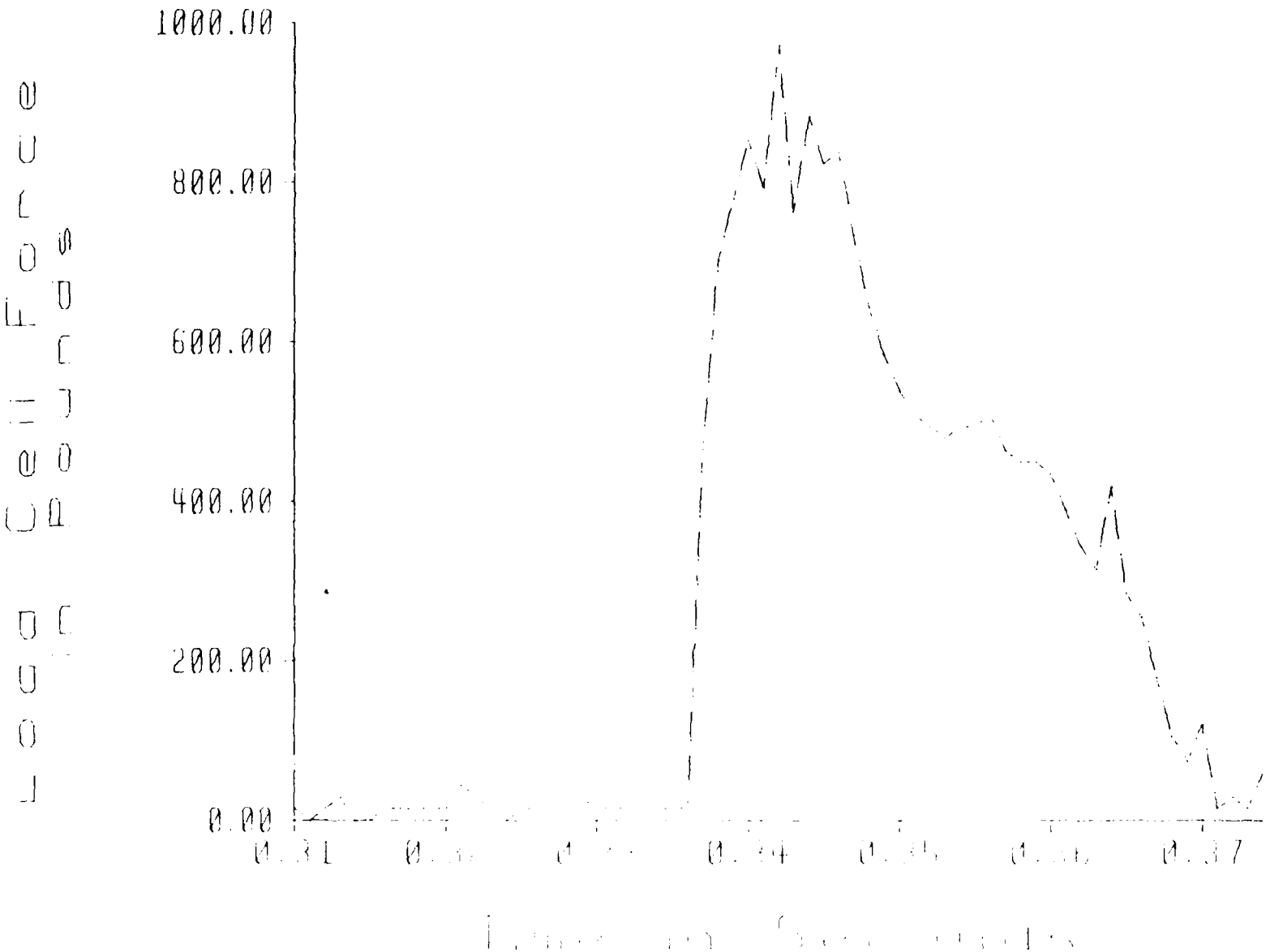
Graph 9: 6d Common Nail

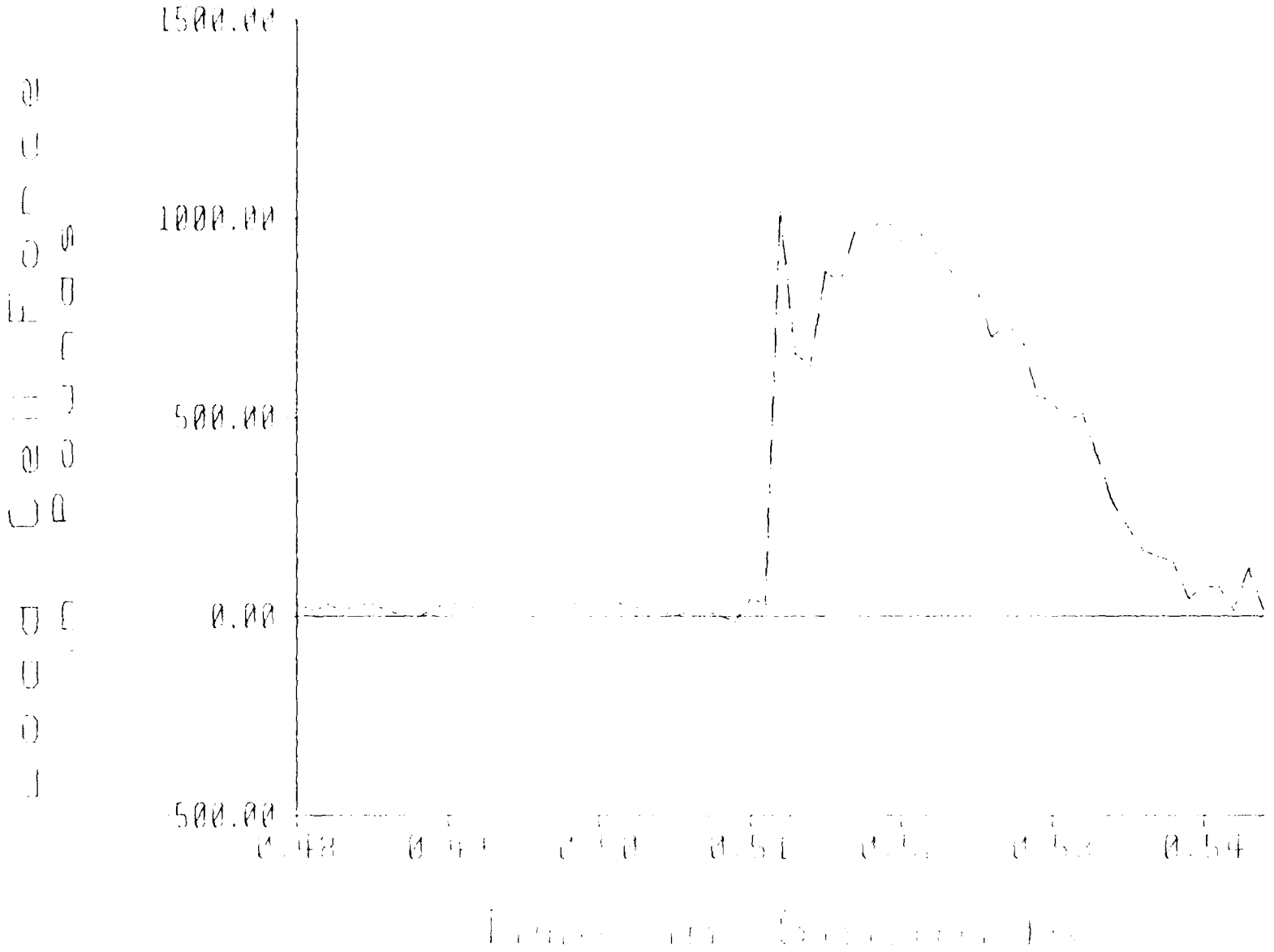
Sample 6



Graph 10: 8d Common Nail

Sample 1

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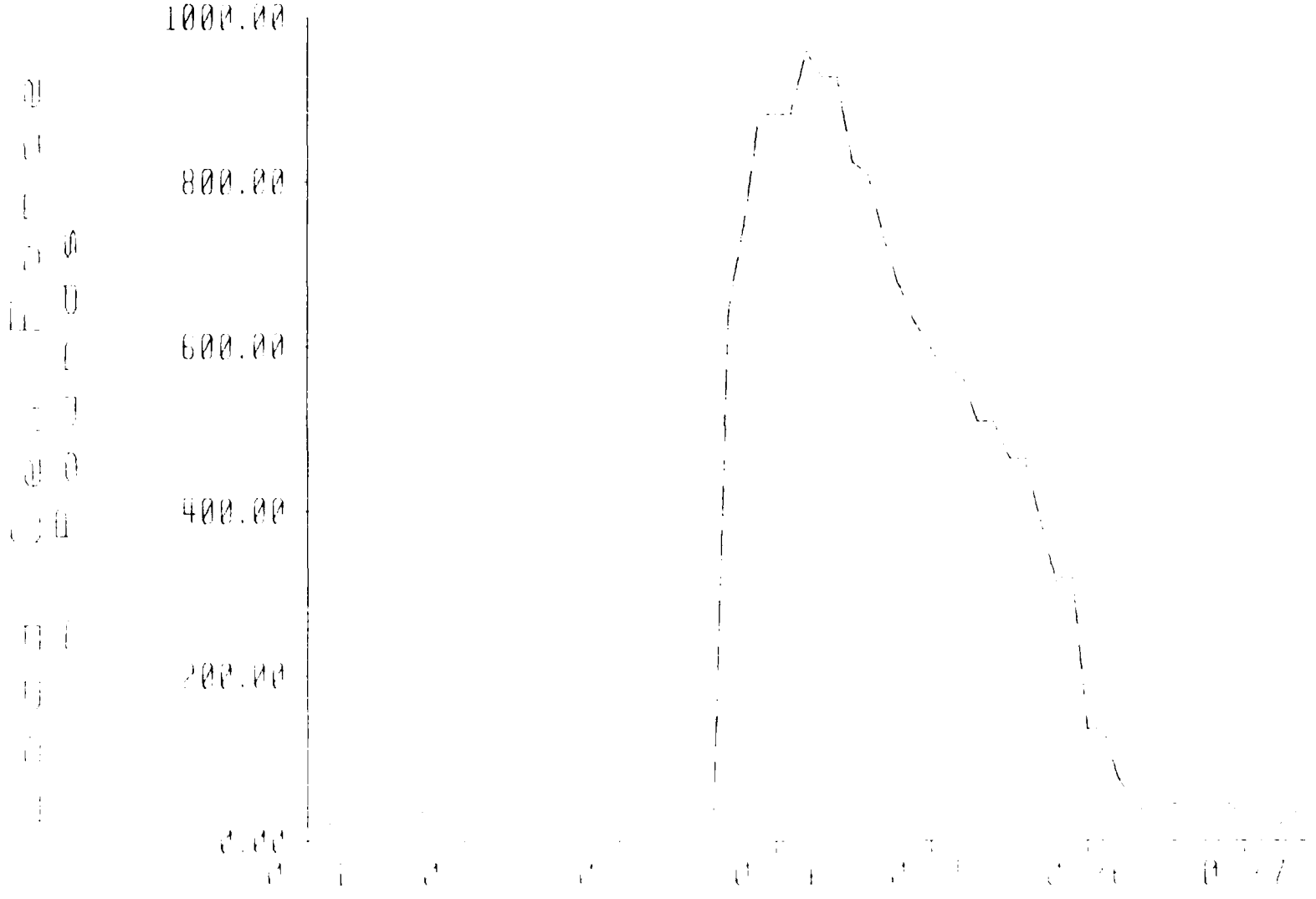
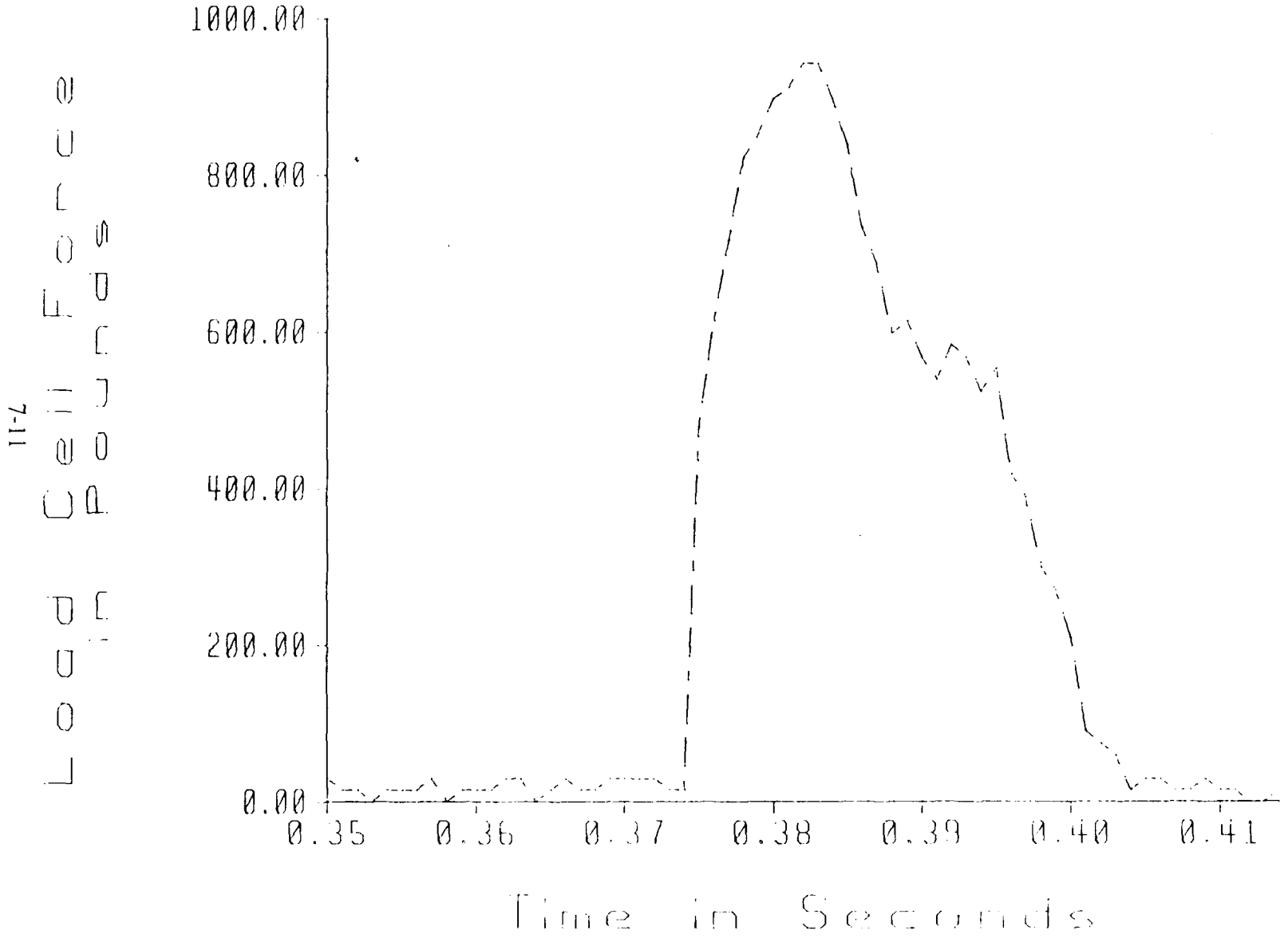
Graph 12: 8d Common Nail

Sample 3



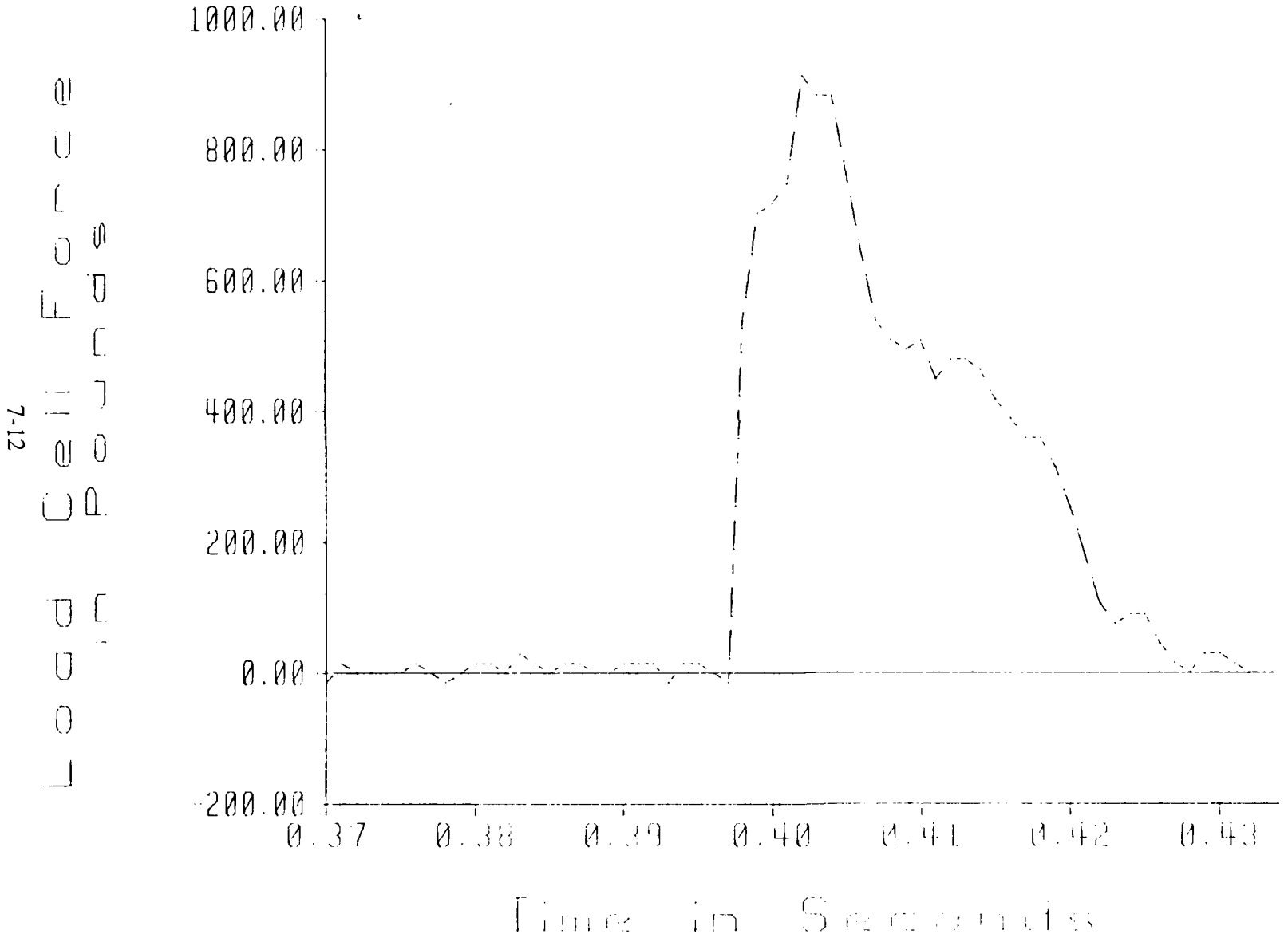
Graph 13: 8d Common Nail

Sample 4



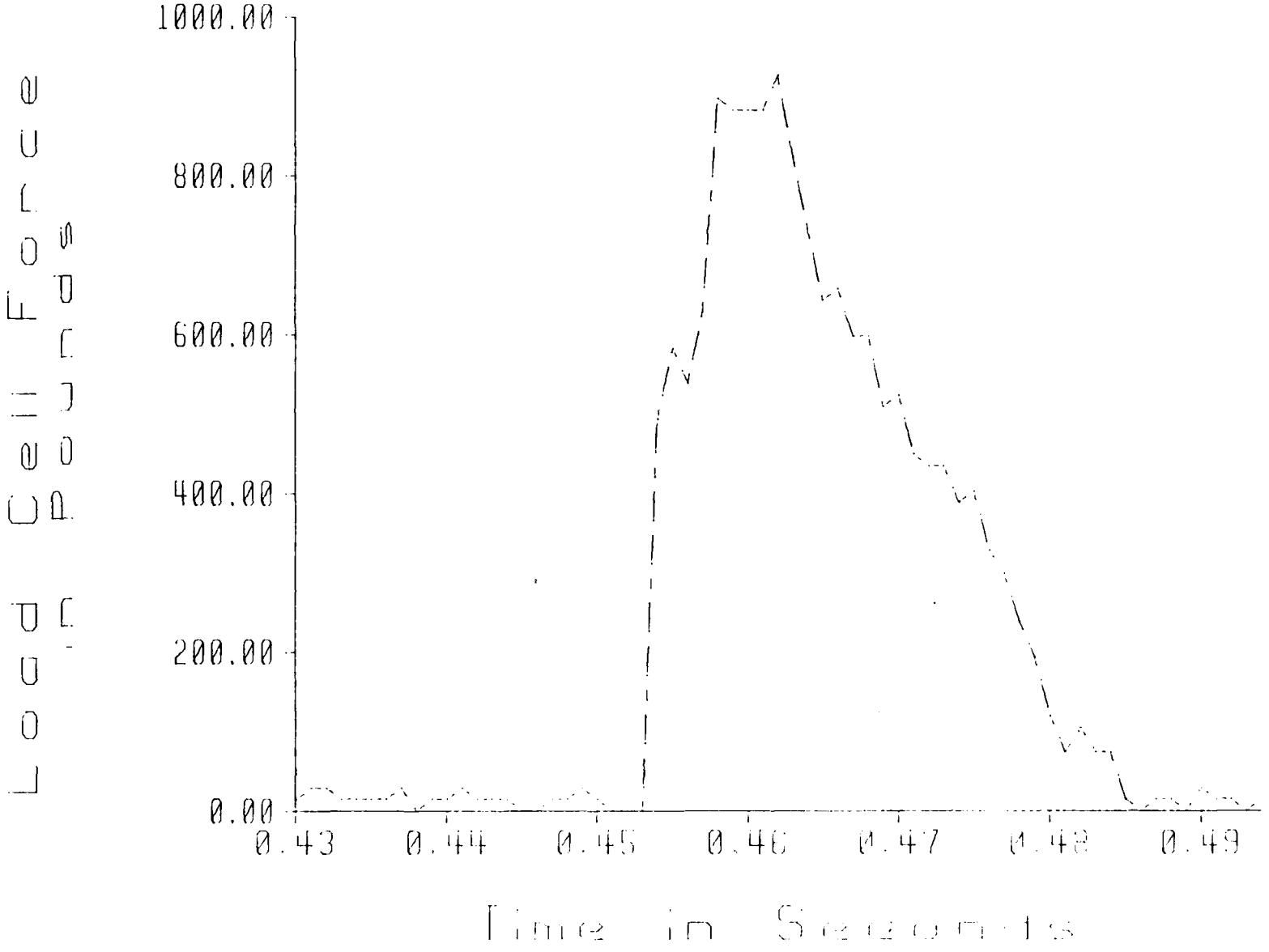
Graph 14: 8d Common Nail

Sample 5



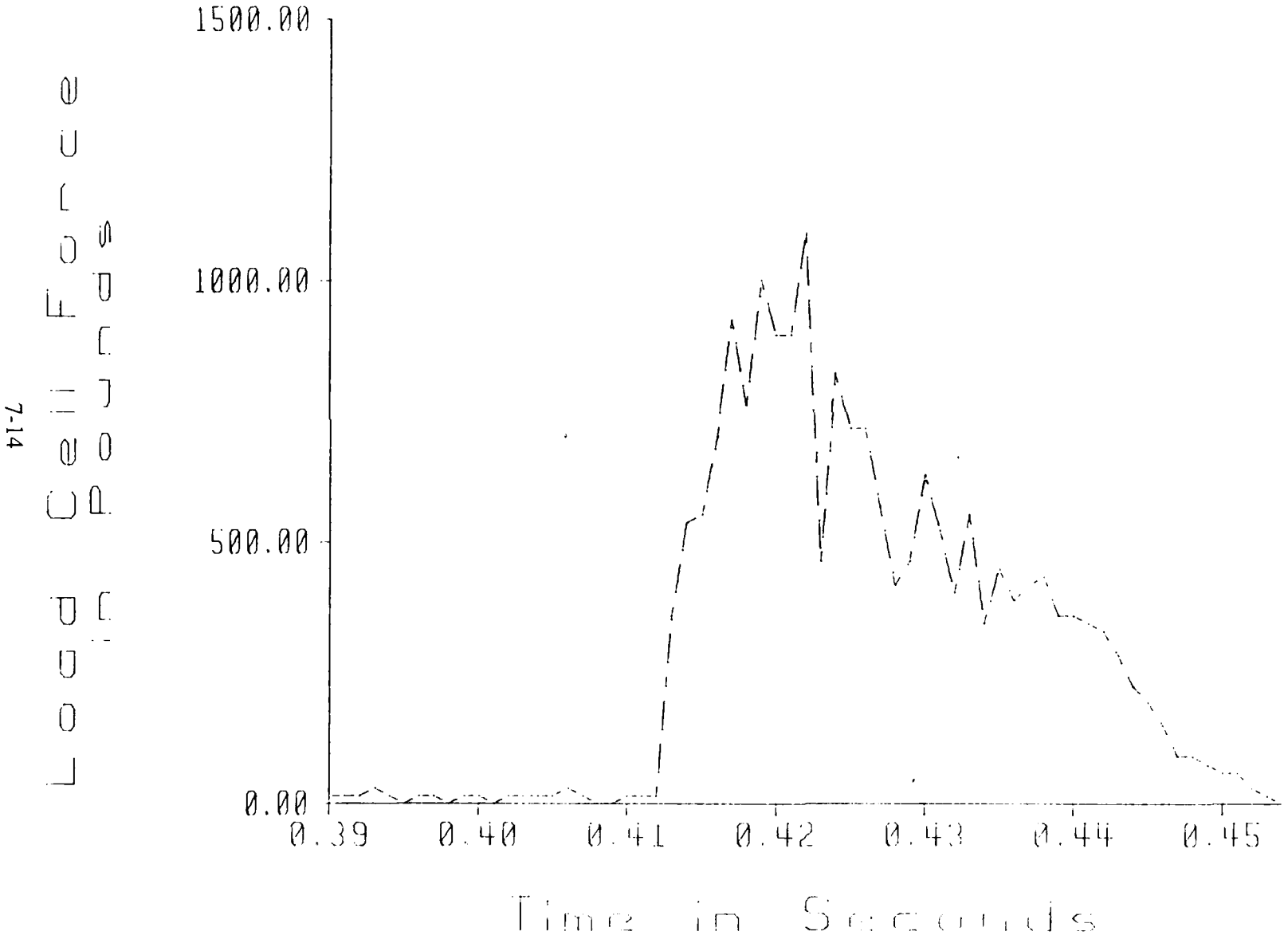
Graph 15: 8d Common Nail

Sample 6

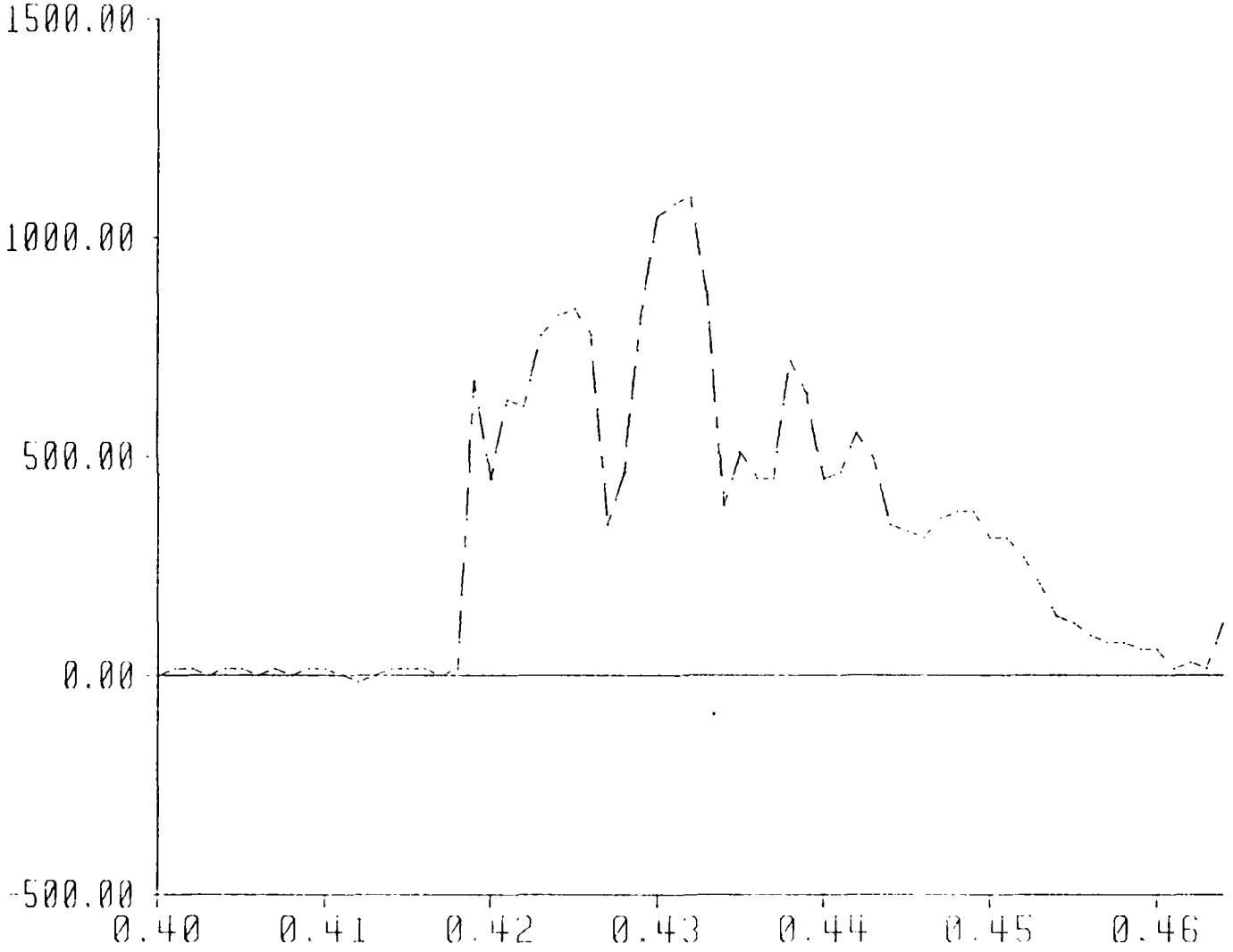


Graph 16: 10d Comm. Nail

Sample 1

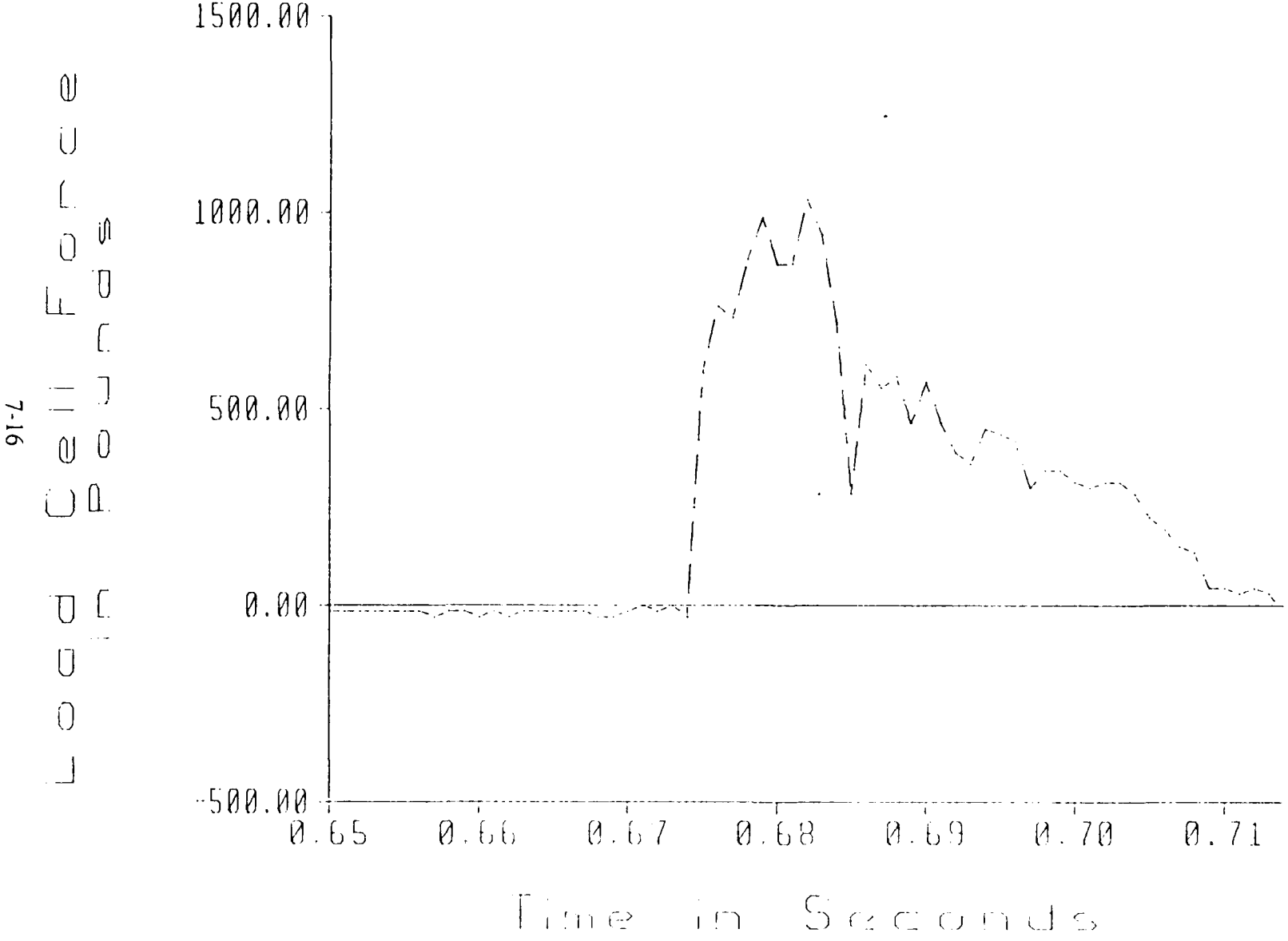


Graph 17: 10d Comm. Nail
Sample 2



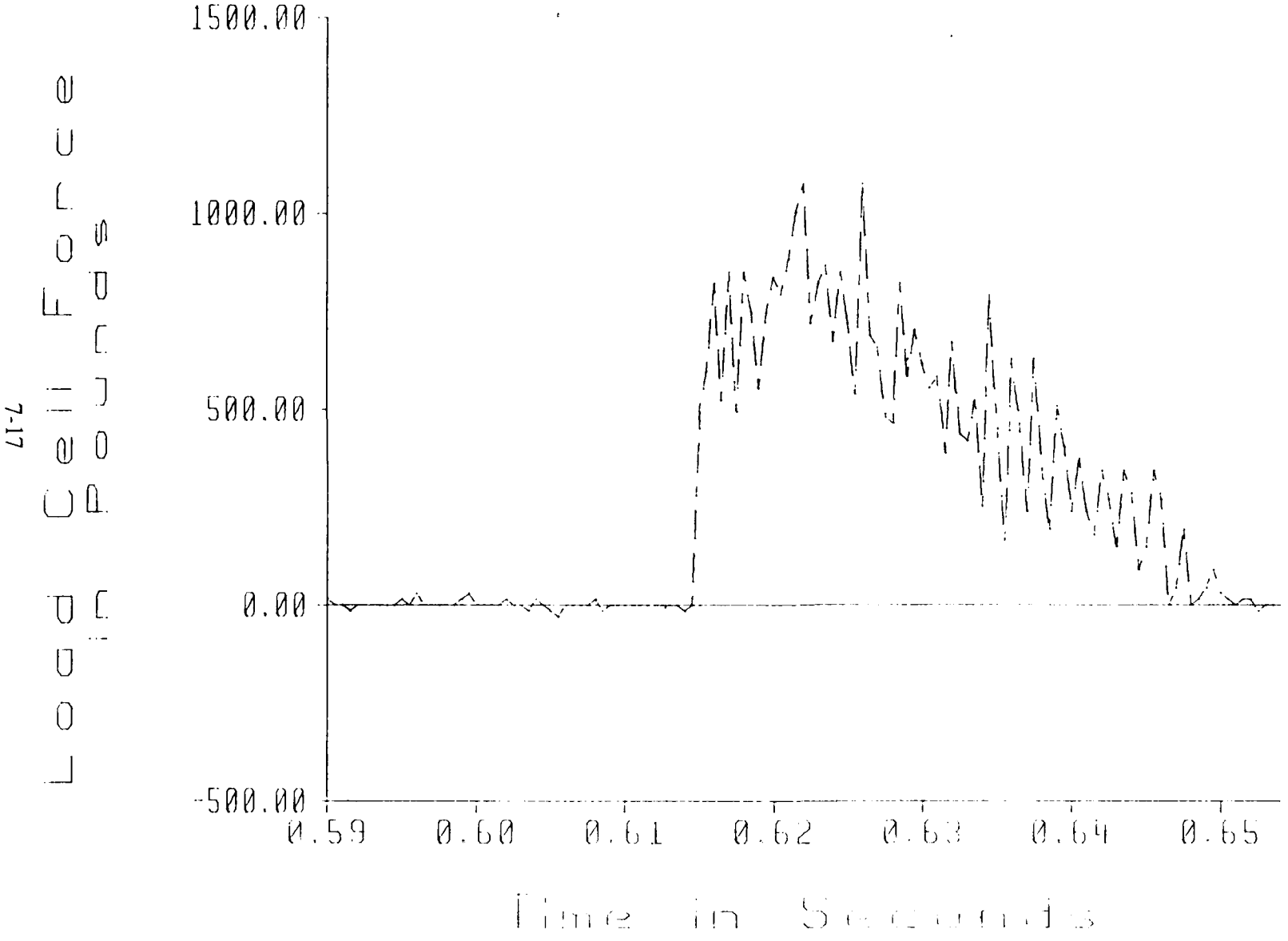
Graph 18: 10d Comm. Nail

Sample 3



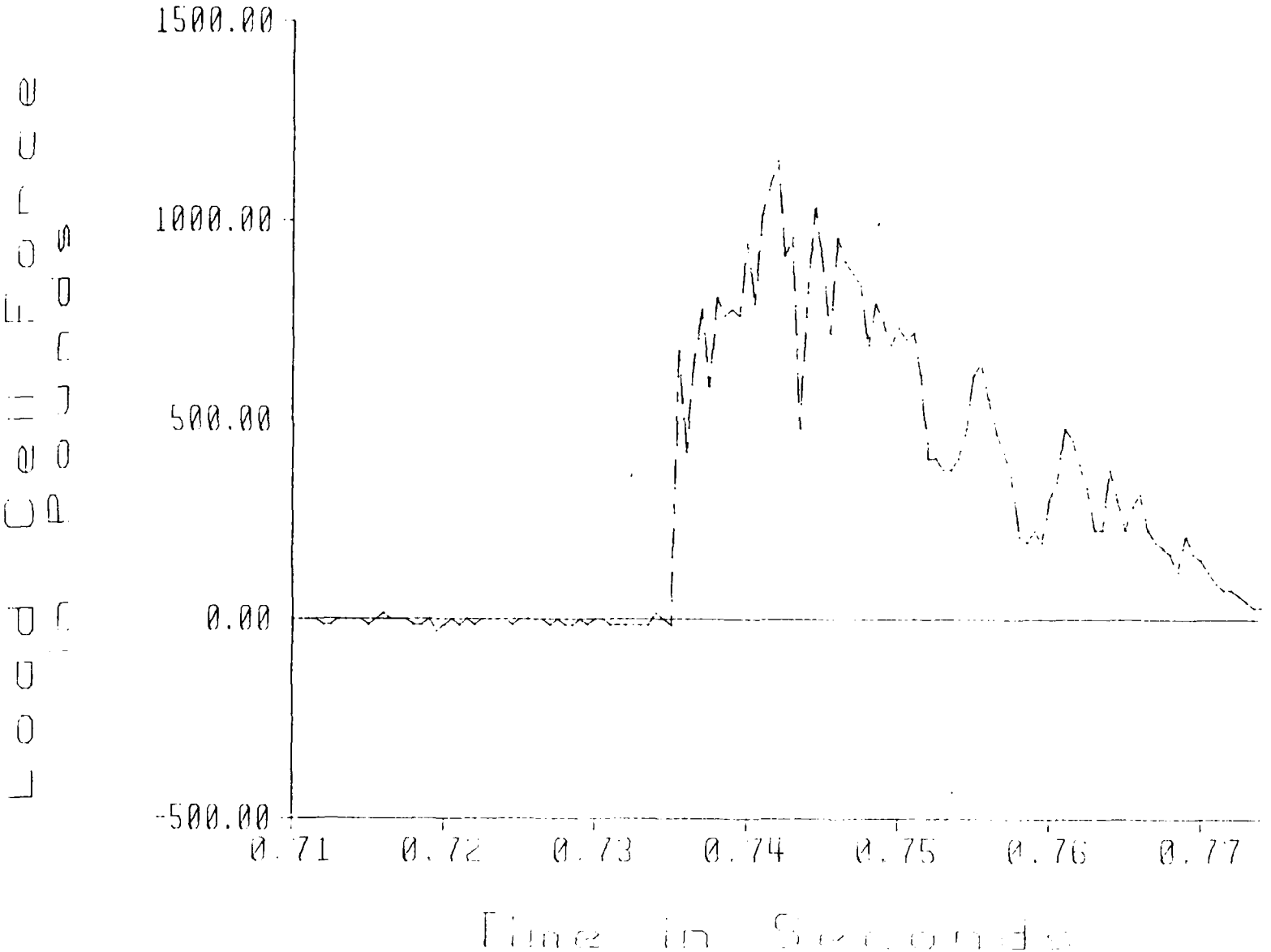
Graph 19: 10d Comm. Nail

Sample 4



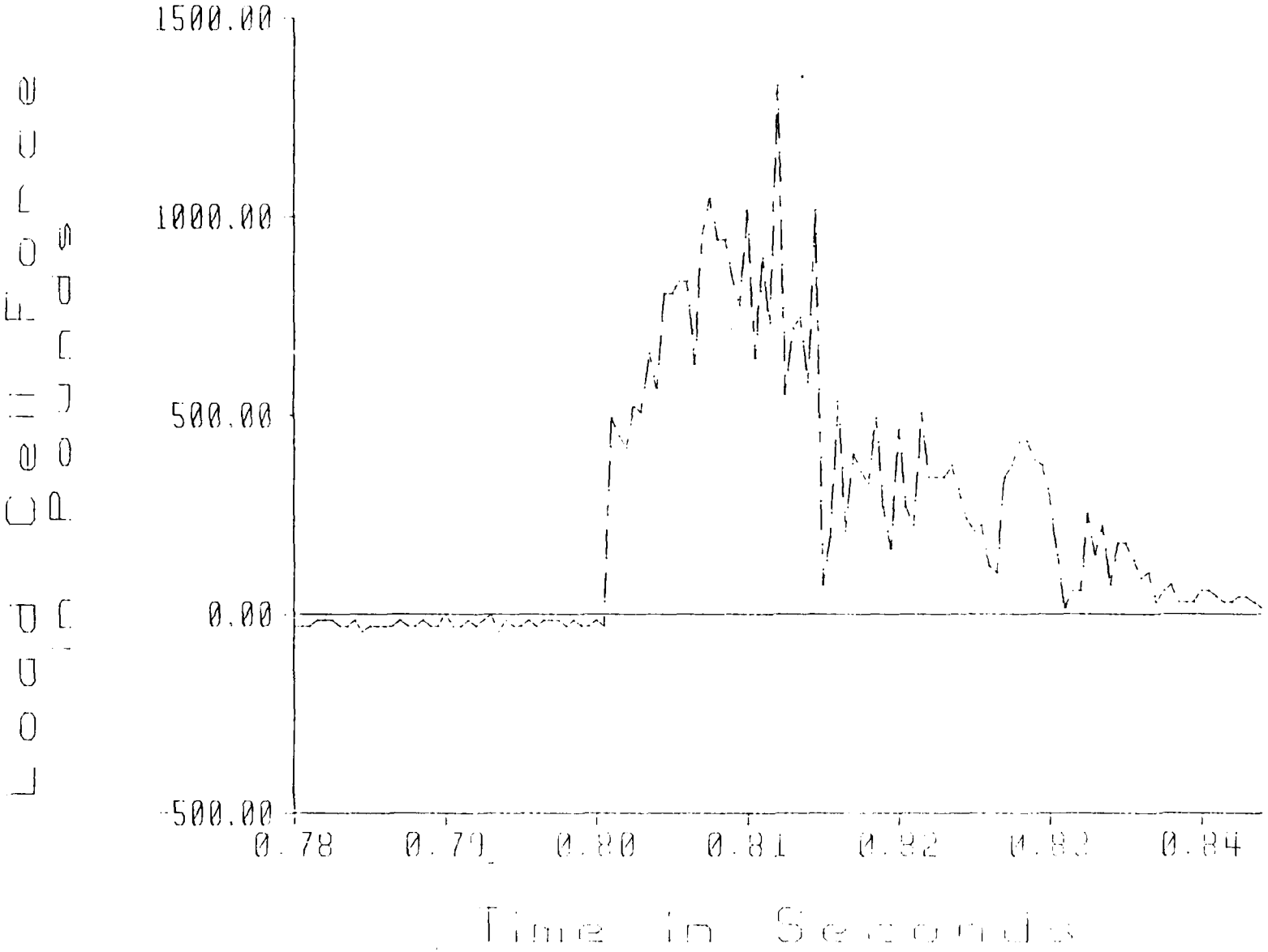
Graph 20: 10d Comm. Nail

Sample 5



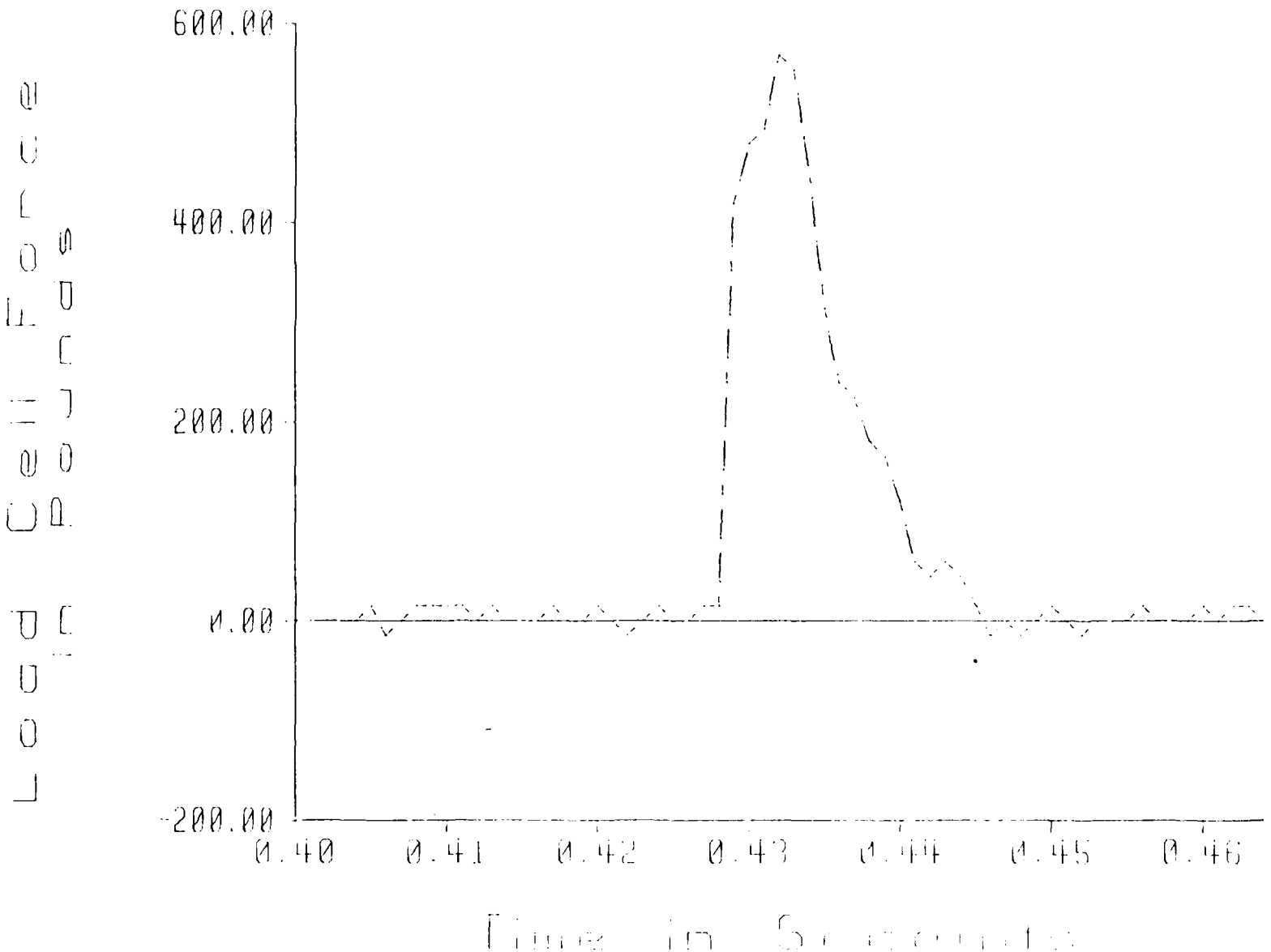
Graph 21: 10d Comm. Nail

Sample 6



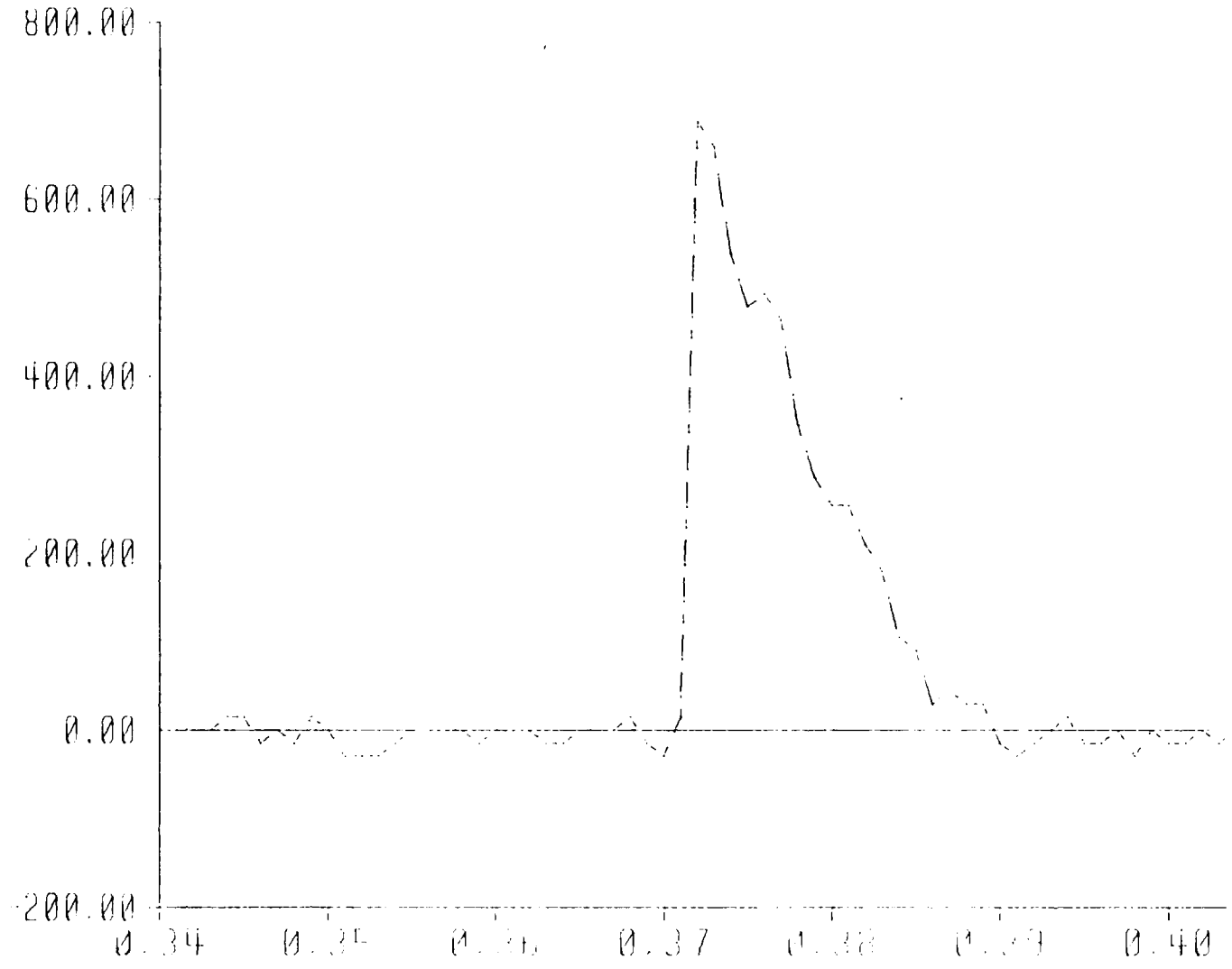
Graph 22: 6d Cooler Nail

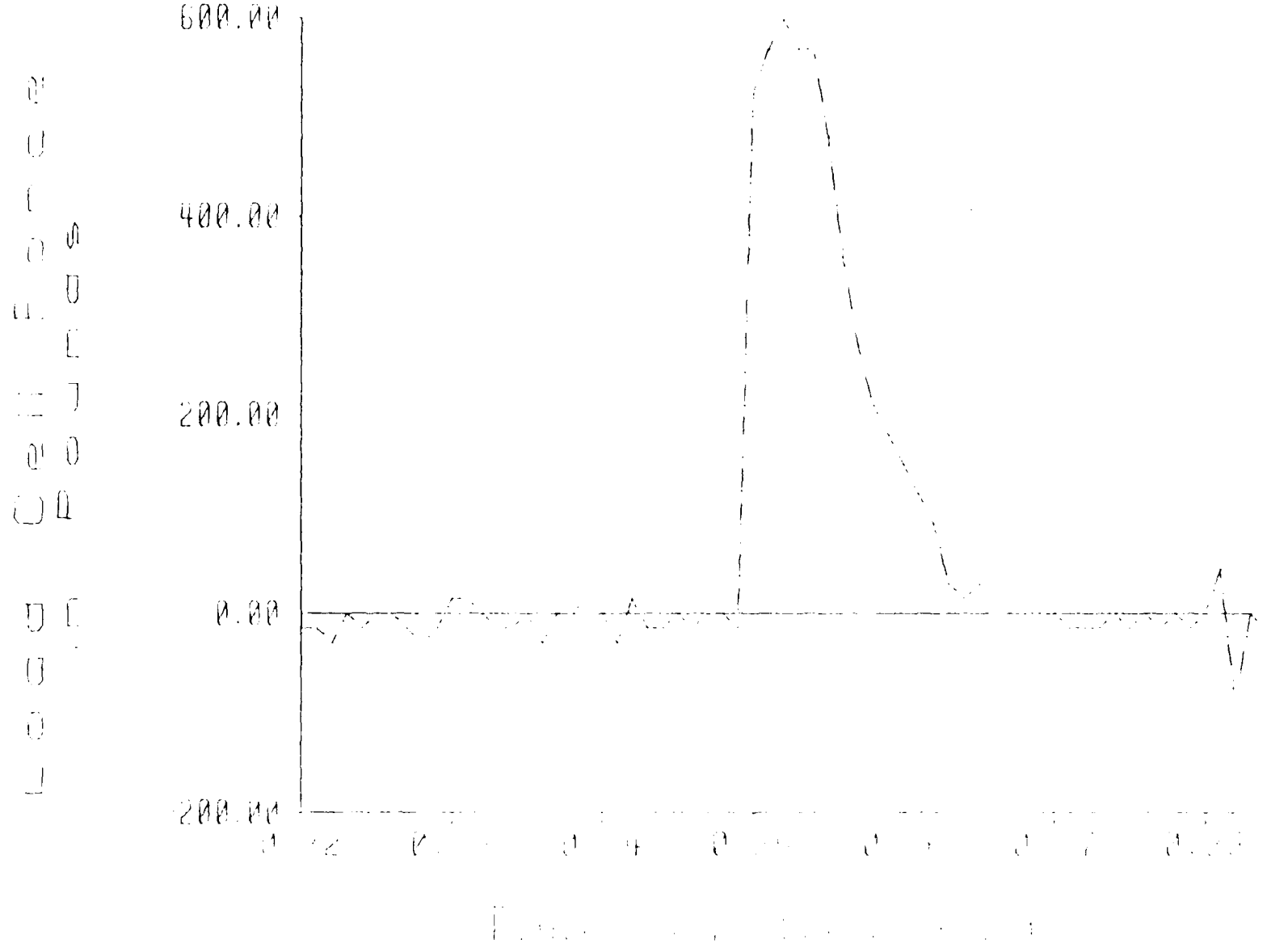
Sample: 1



Graph 23: 6d Cooler Nail

Sample 2

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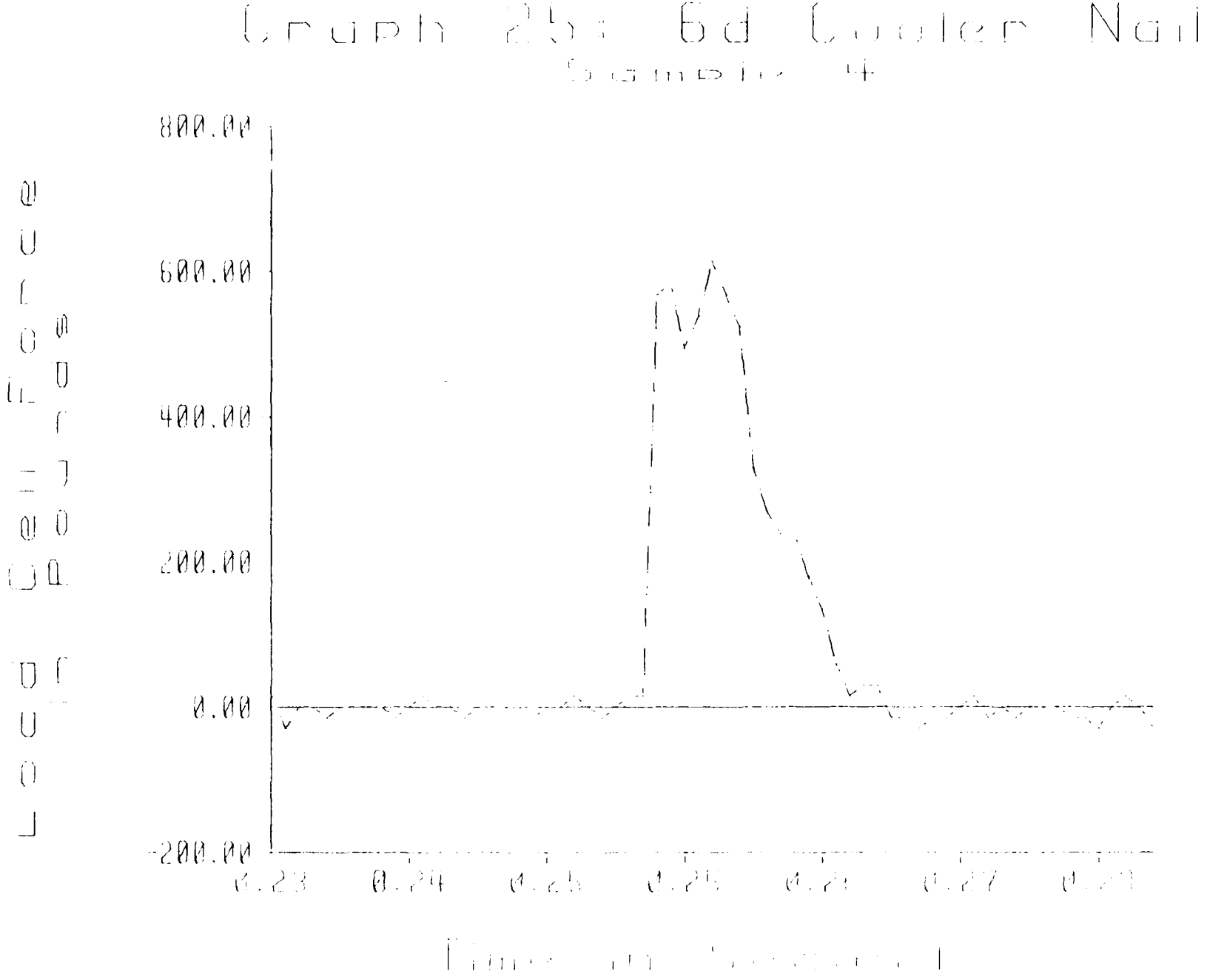
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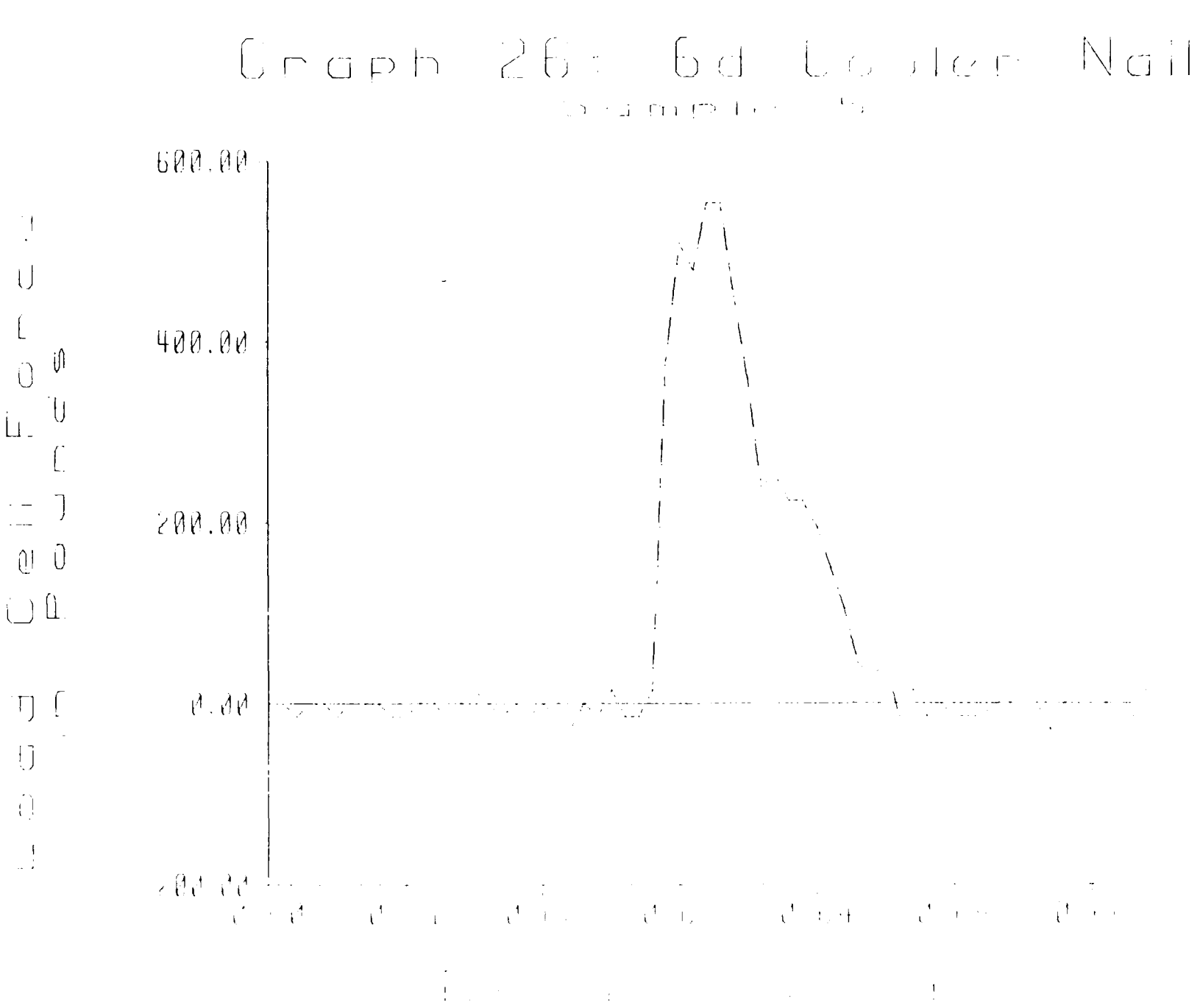
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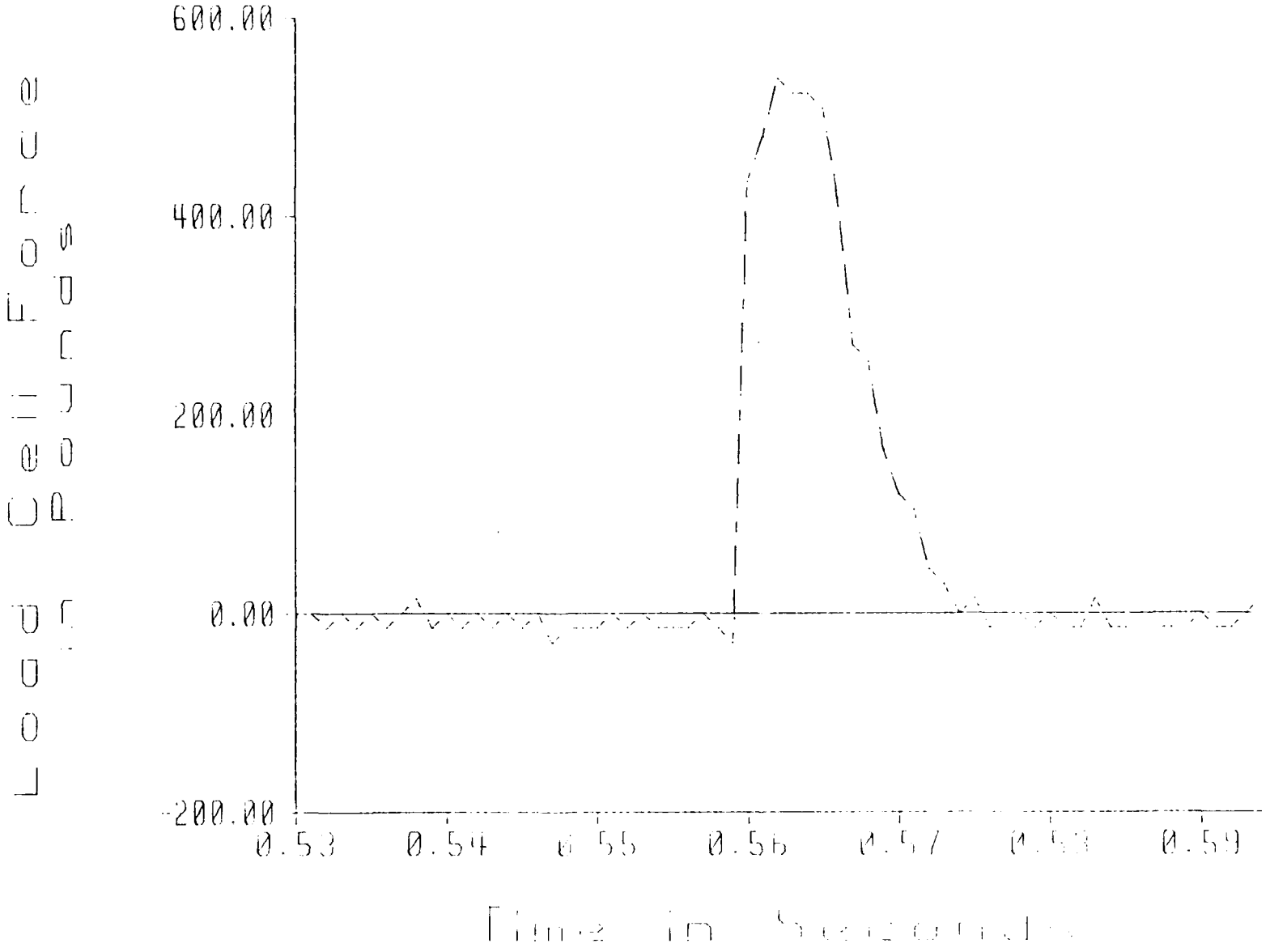
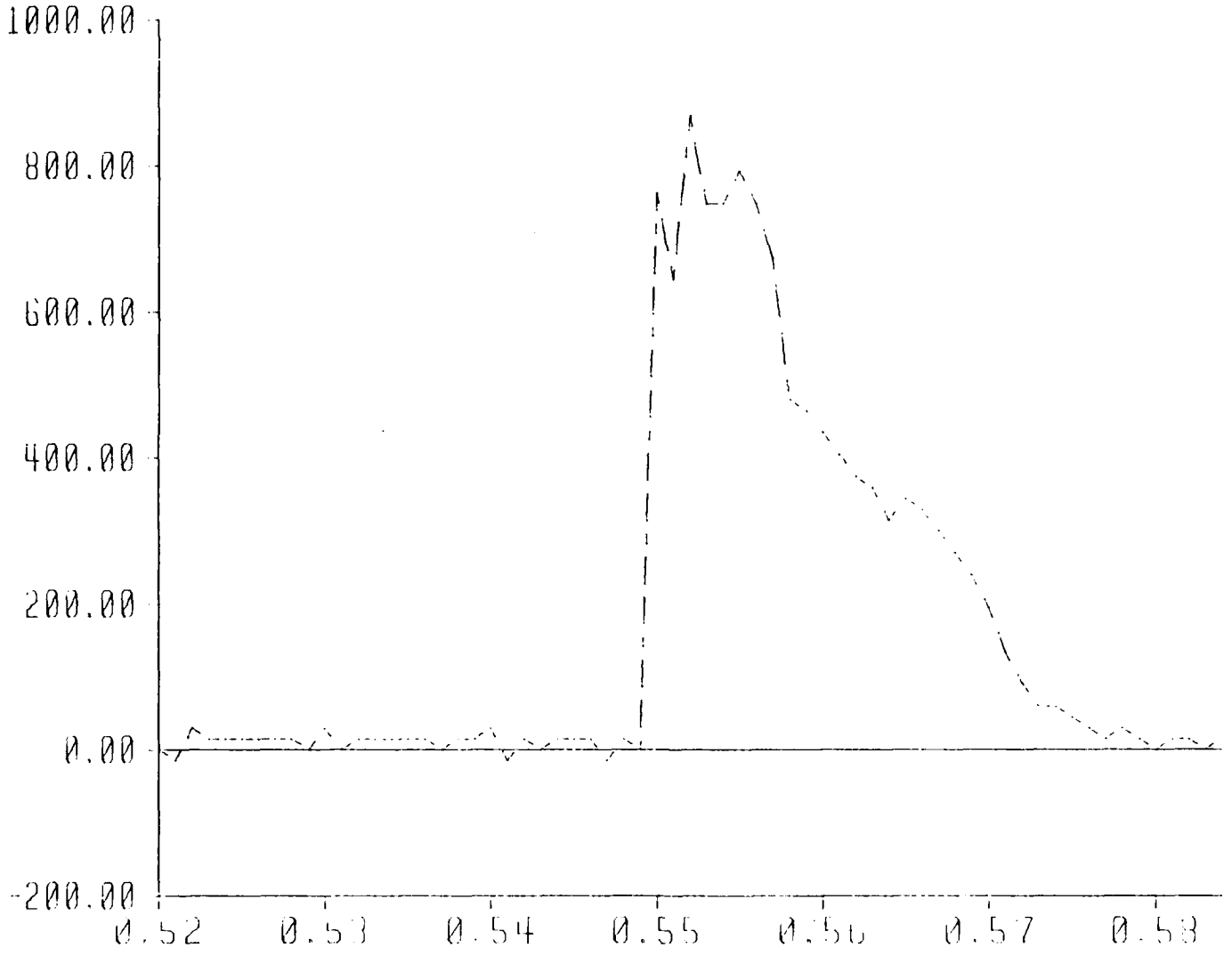
Graph 27: 6d Cooler Nail

Sample 6



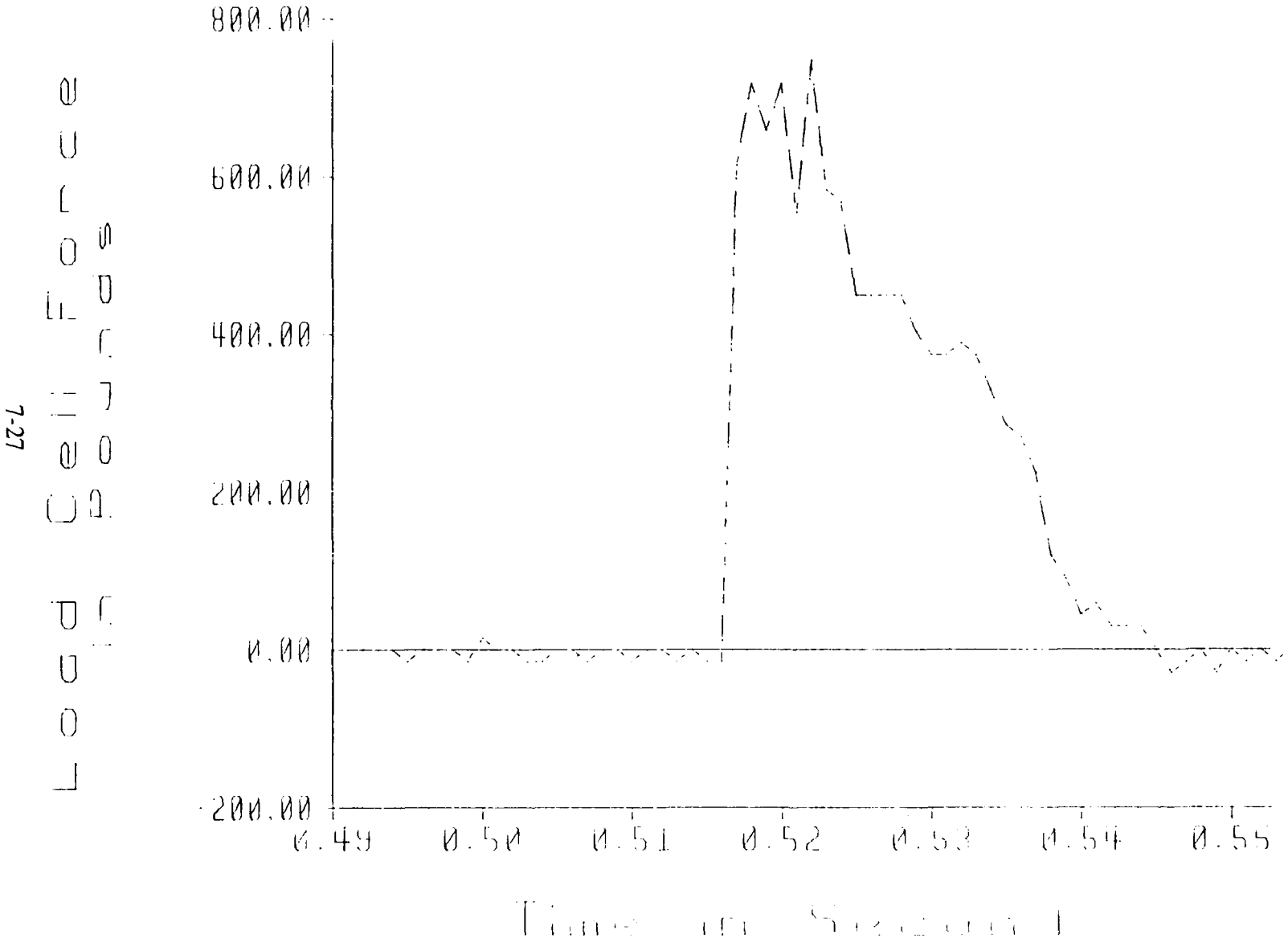
Graph 28: 8d Cooler Nail

Sample 1



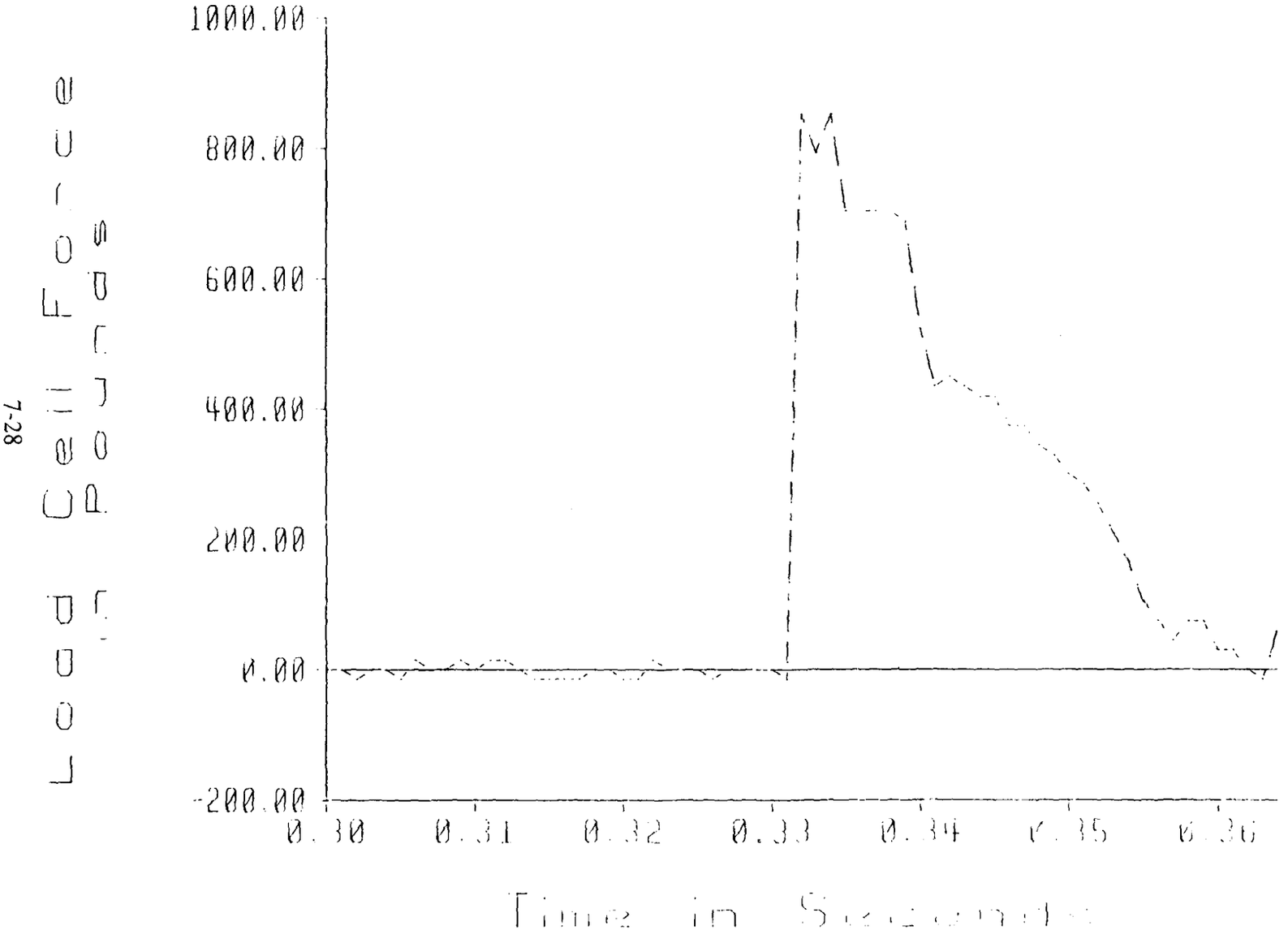
Graph 29: 8d Cooler Nail

Sample 2



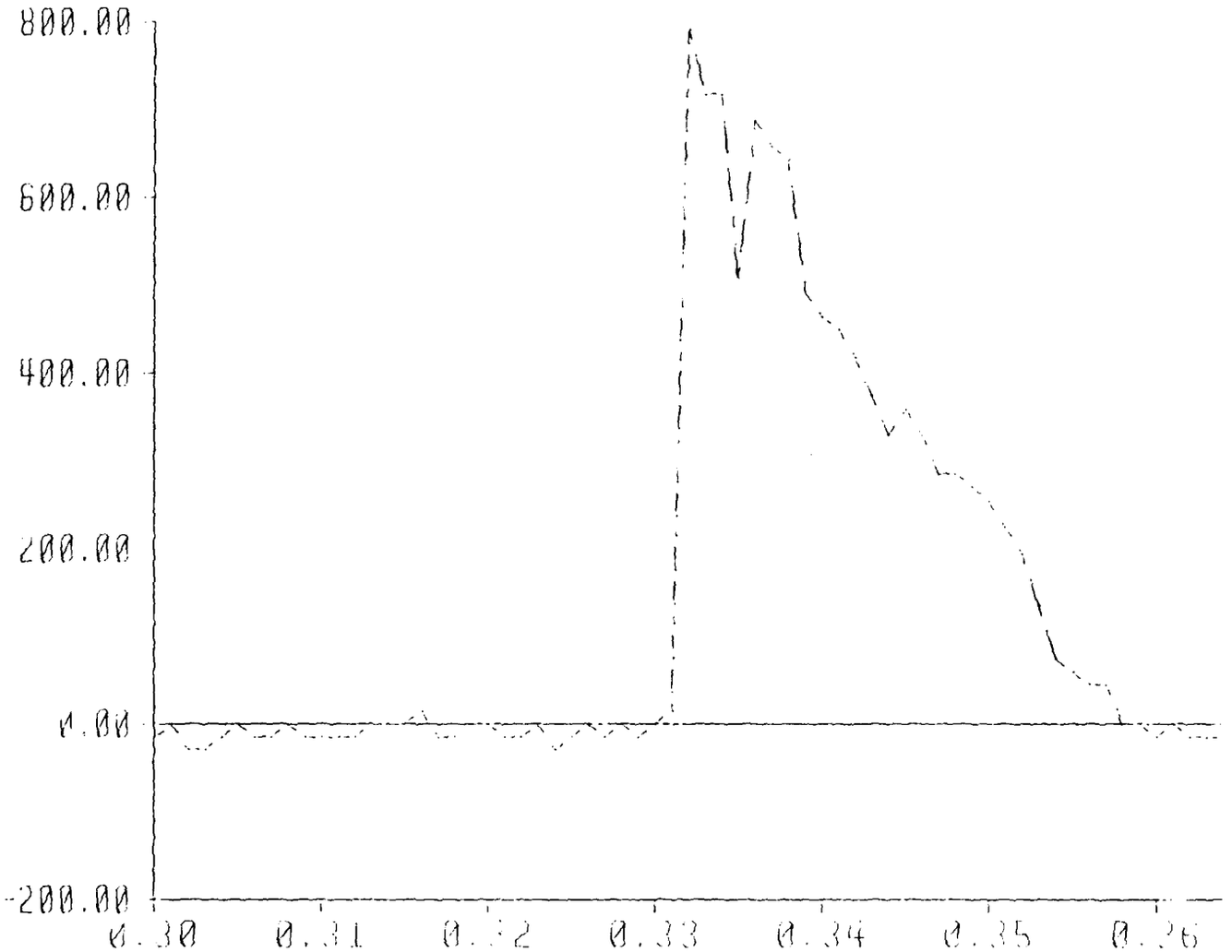
Graph 30: 8d Cooler Nail

Sample 3



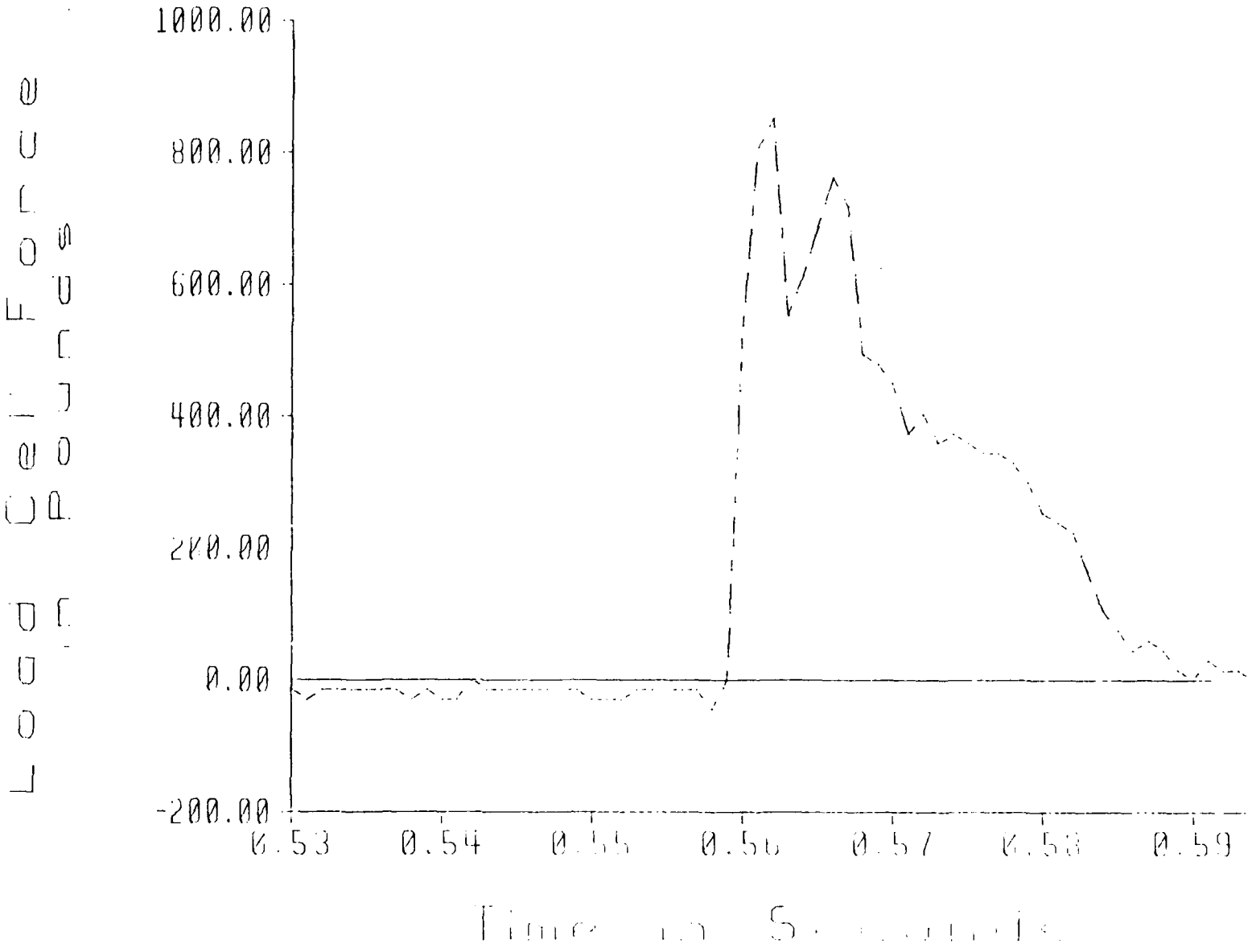
Graph 31: 8d Cooler Nail

Sample 4

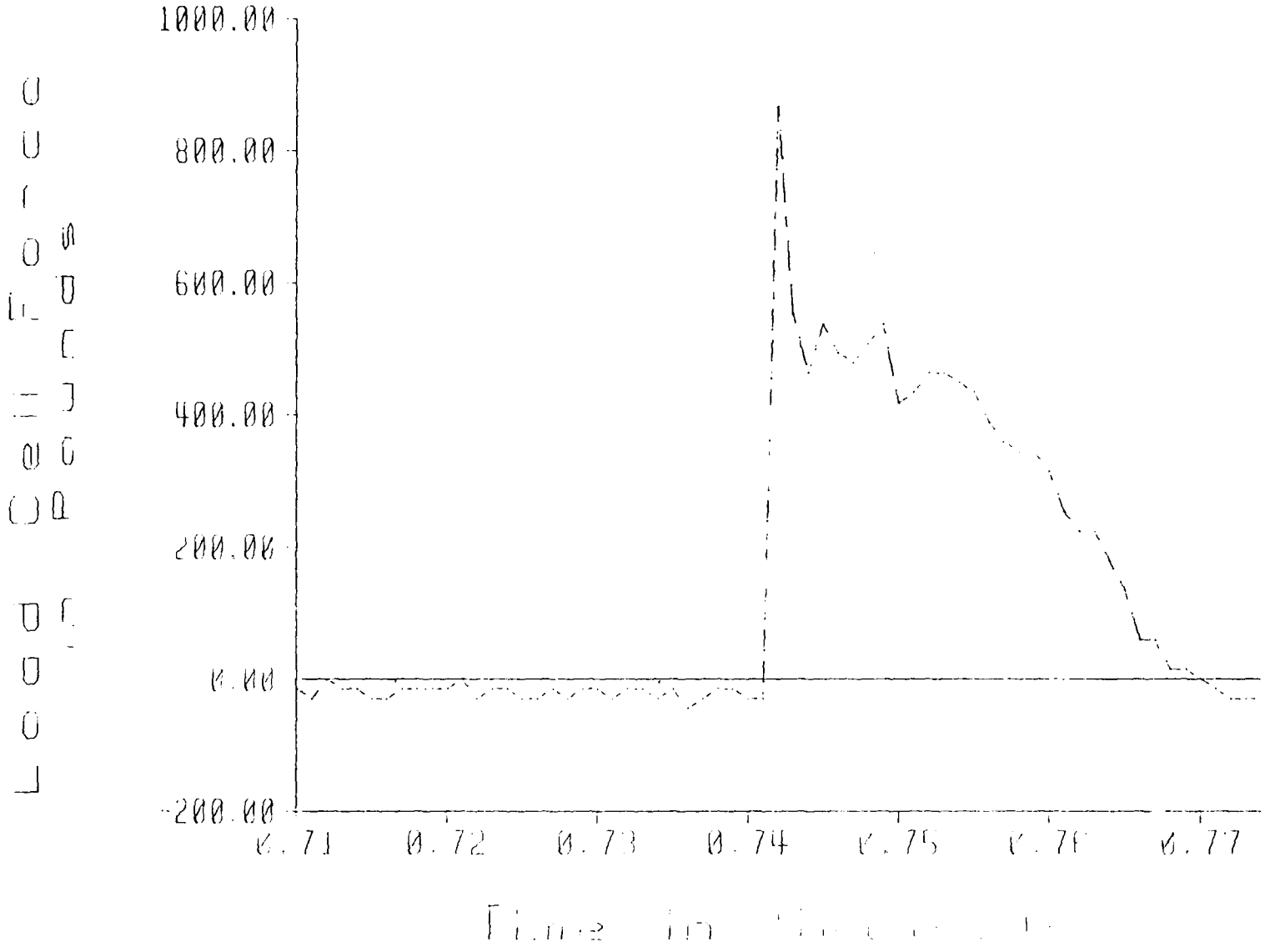


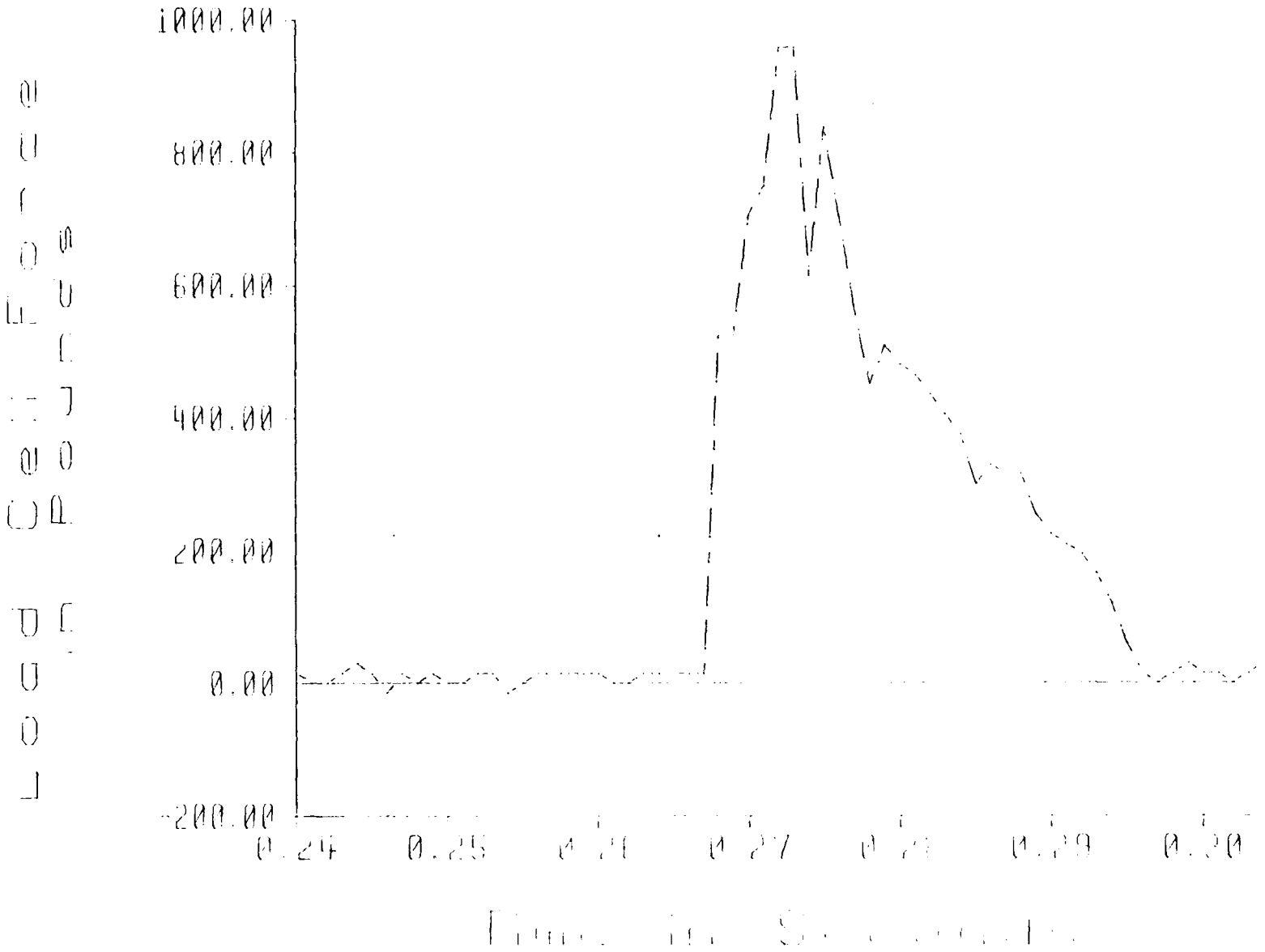
Graph 32: 8d Cooler Nail

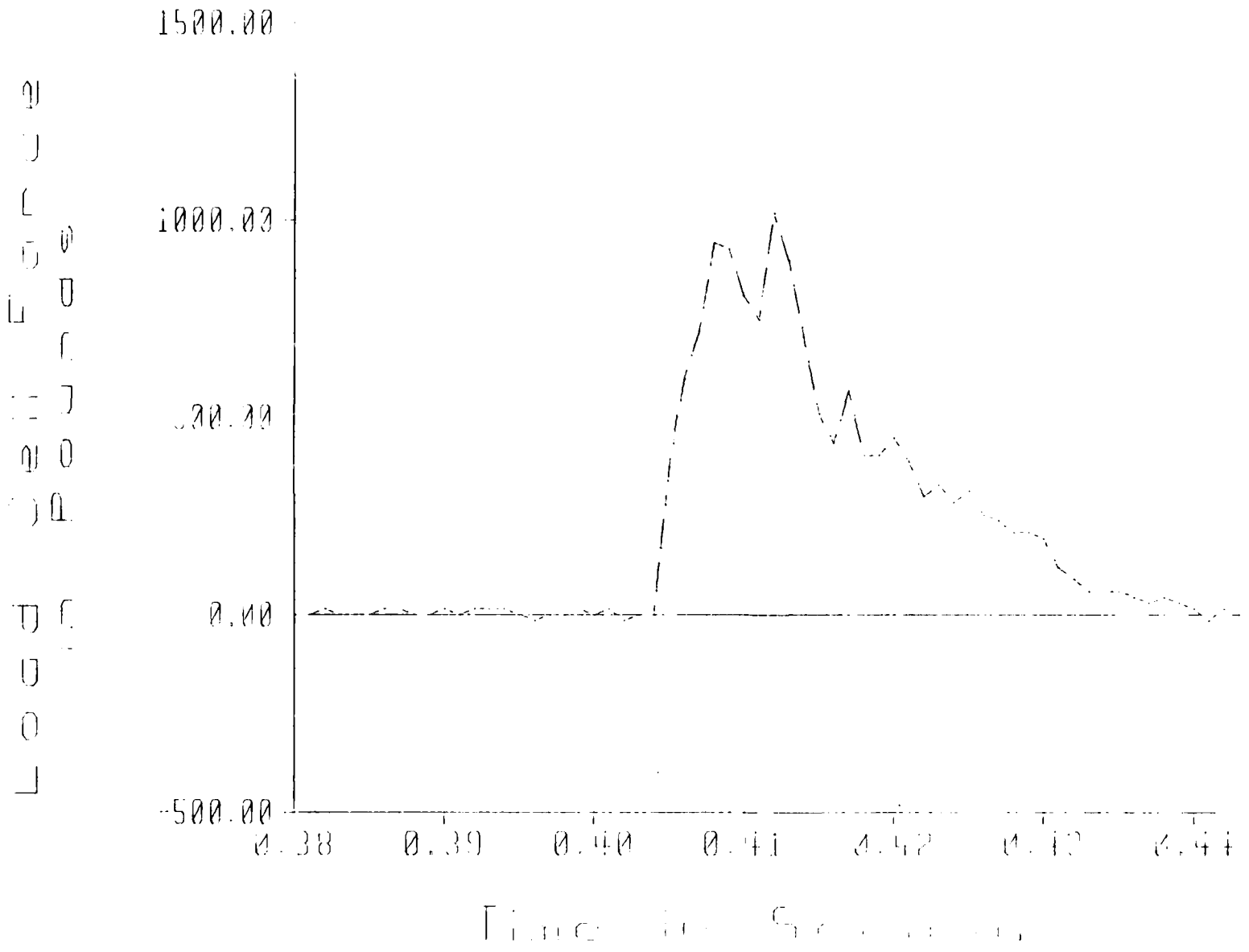
Sample 5



Graph 33: 8d Cooler Nail
Sample 6

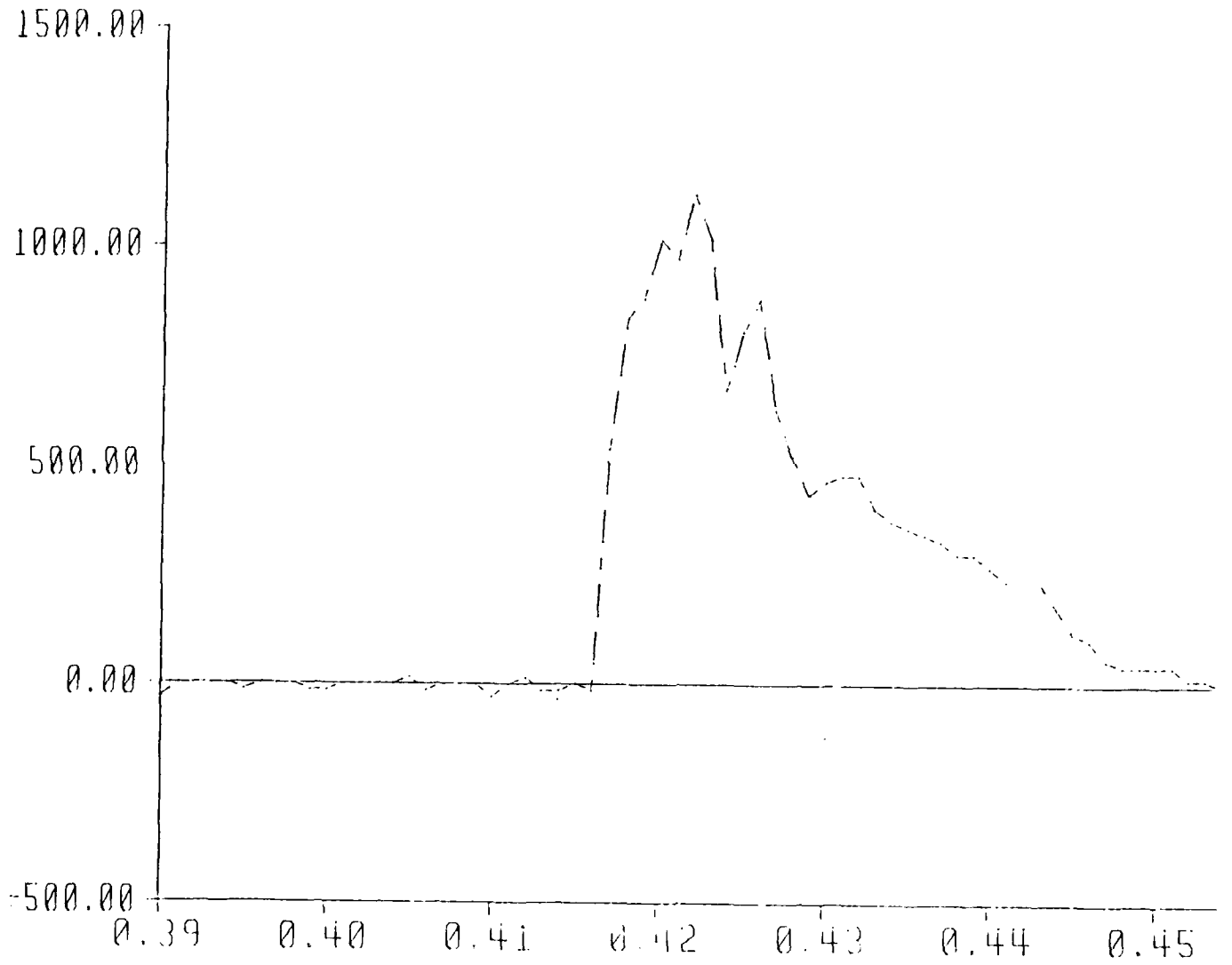



1000.00
800.00
600.00
400.00
200.00
0.00
-200.00
0.24
0.25
0.27
0.29
0.30


1500.00
1000.00
0.00
-500.00
0.38
0.39
0.40
0.41
0.42
0.43
0.44

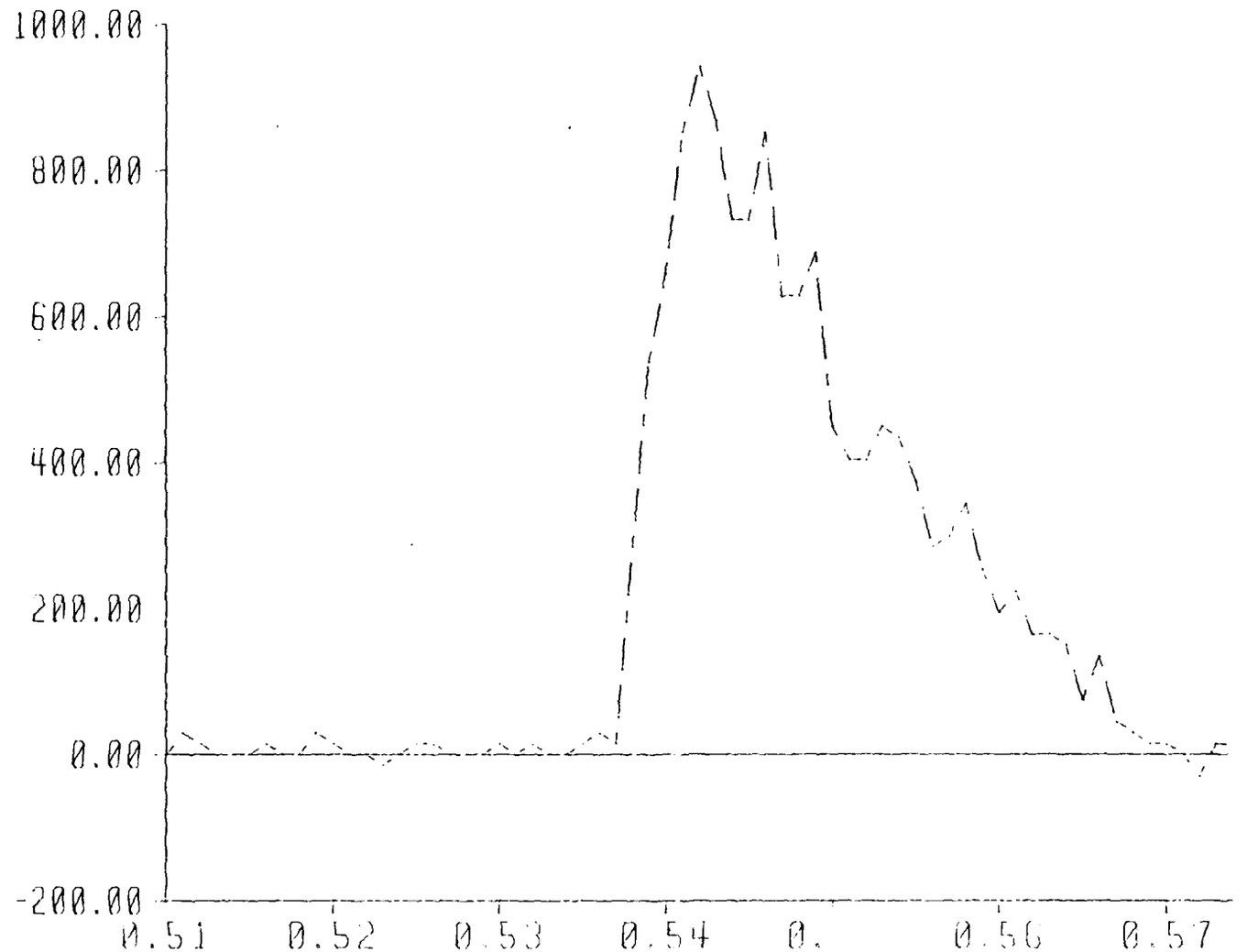
Graph 36: 10d Cooler Ni.

Sample 3



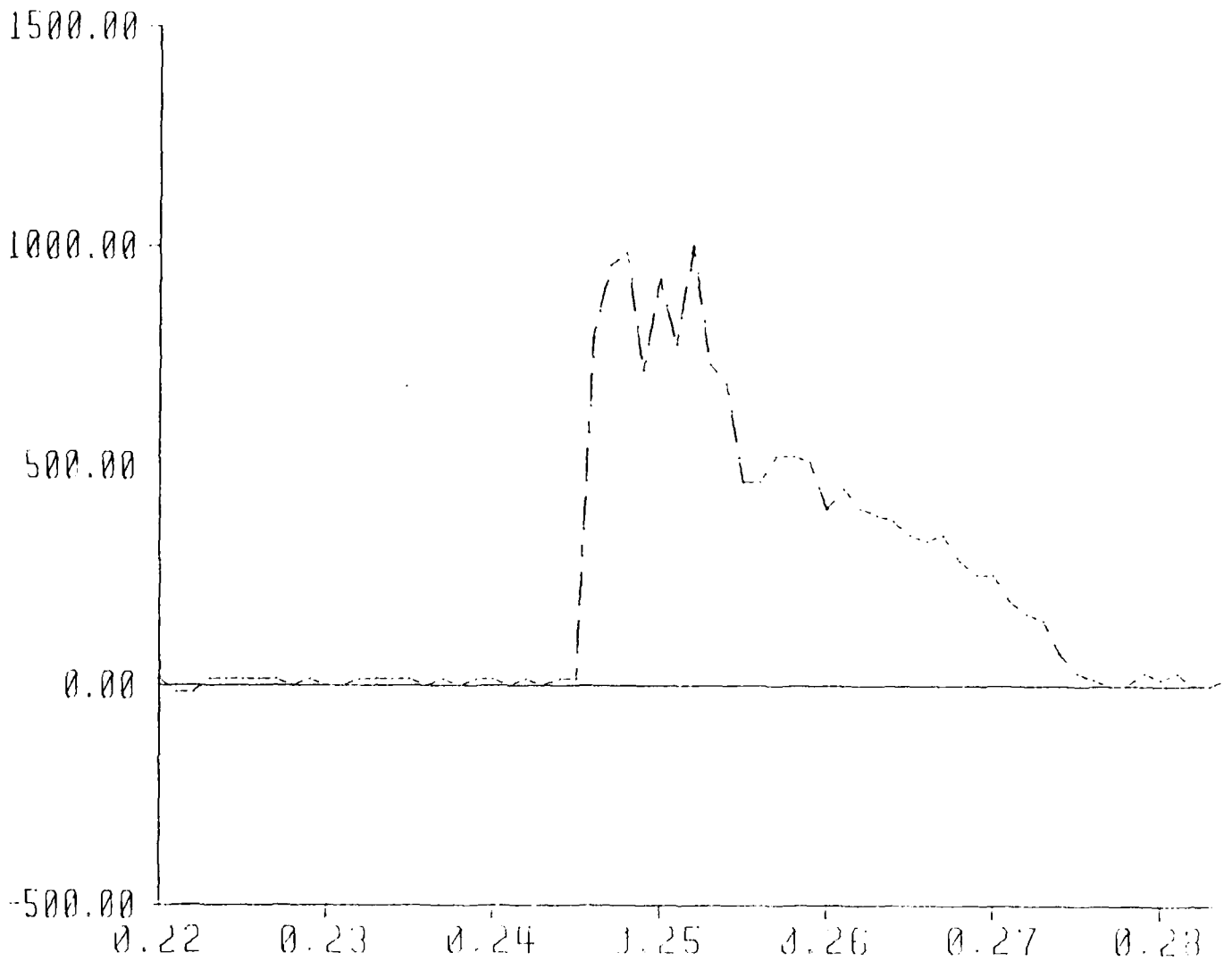
Graph 37: 10d Cooler Ni.

Sample 4



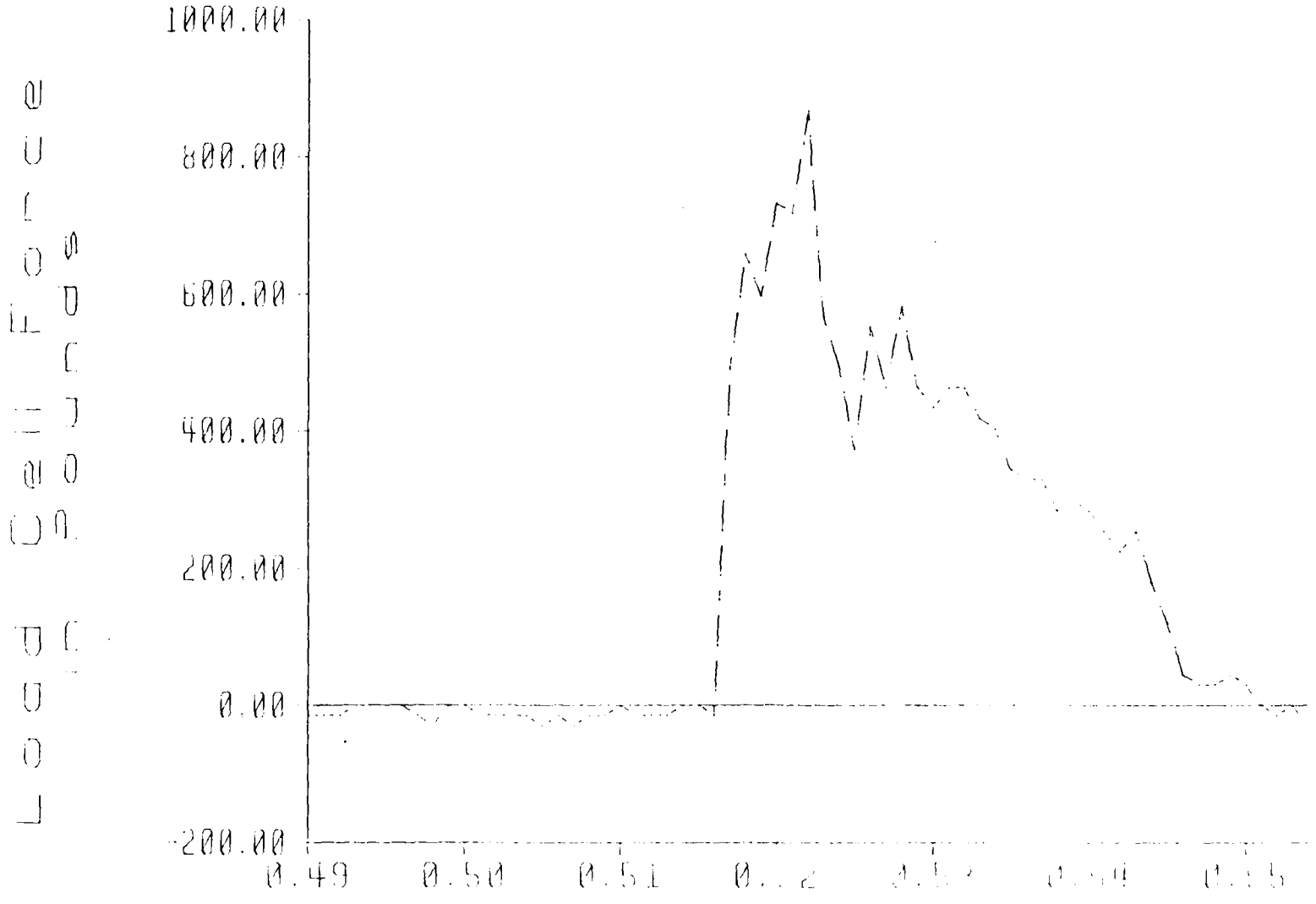
Graph 38: 10d Cooler Ni.

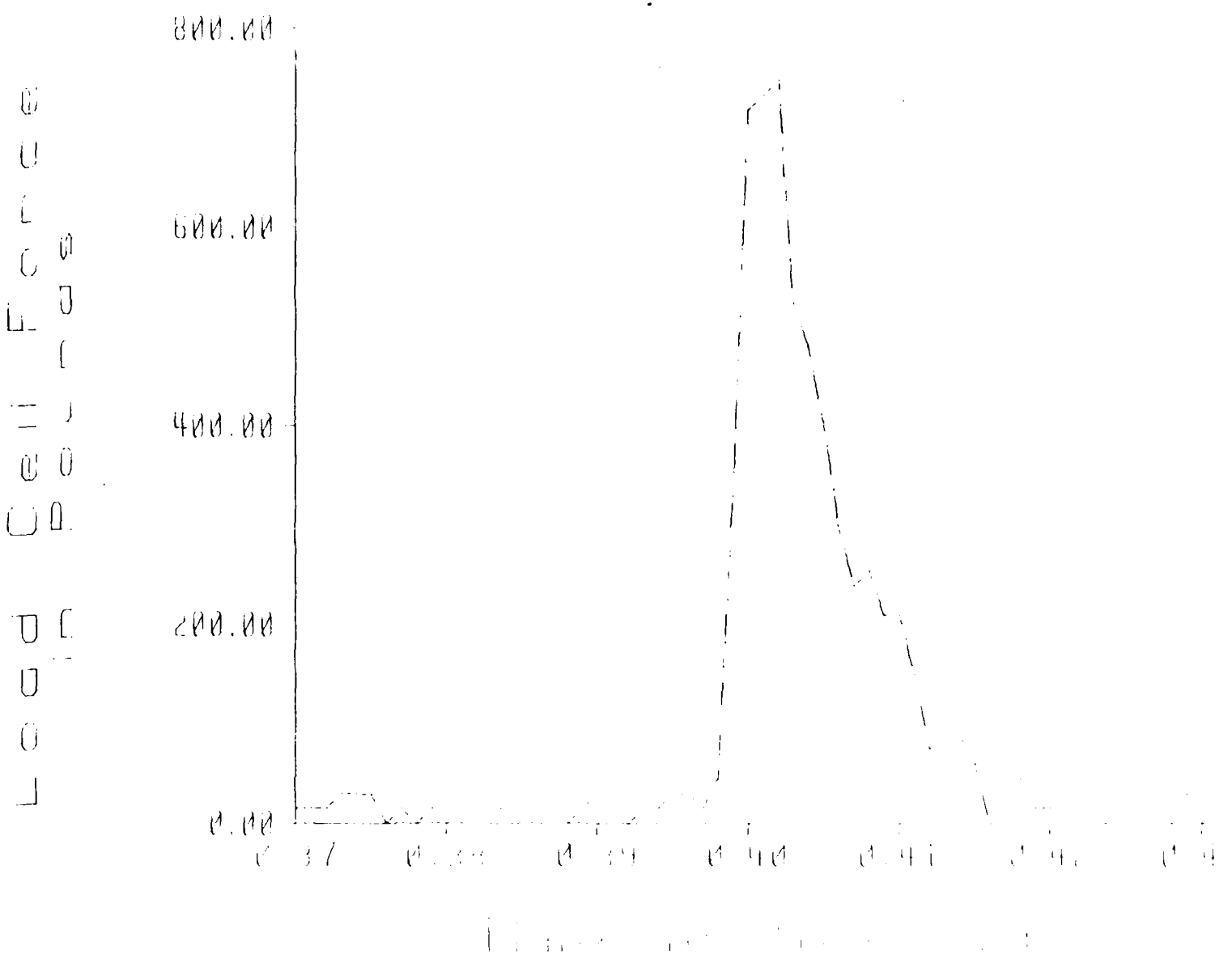
Sample 5



Graph 39: 10d Cooler Ni

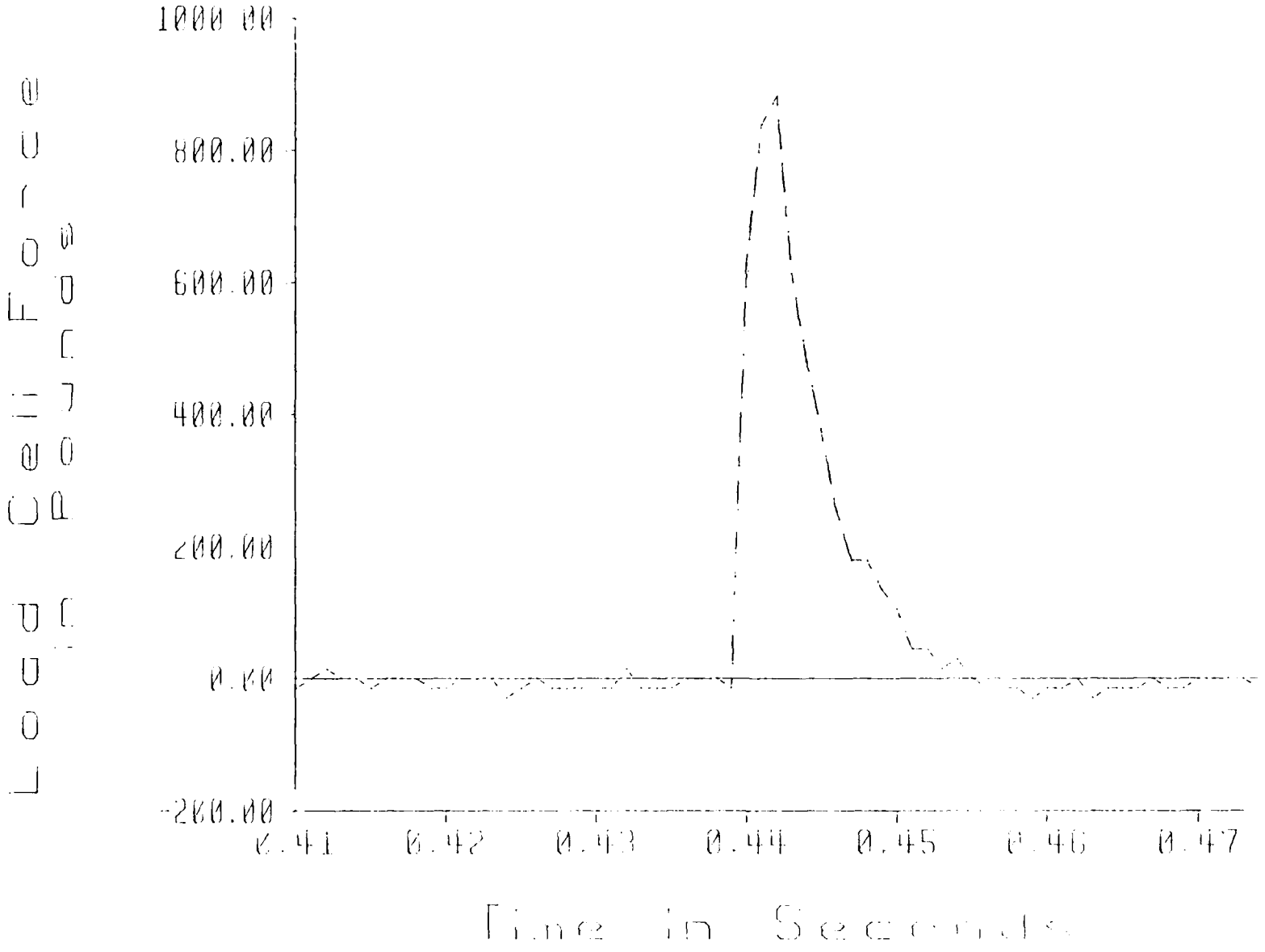
Sample 6




800.00
600.00
400.00
200.00
0.00

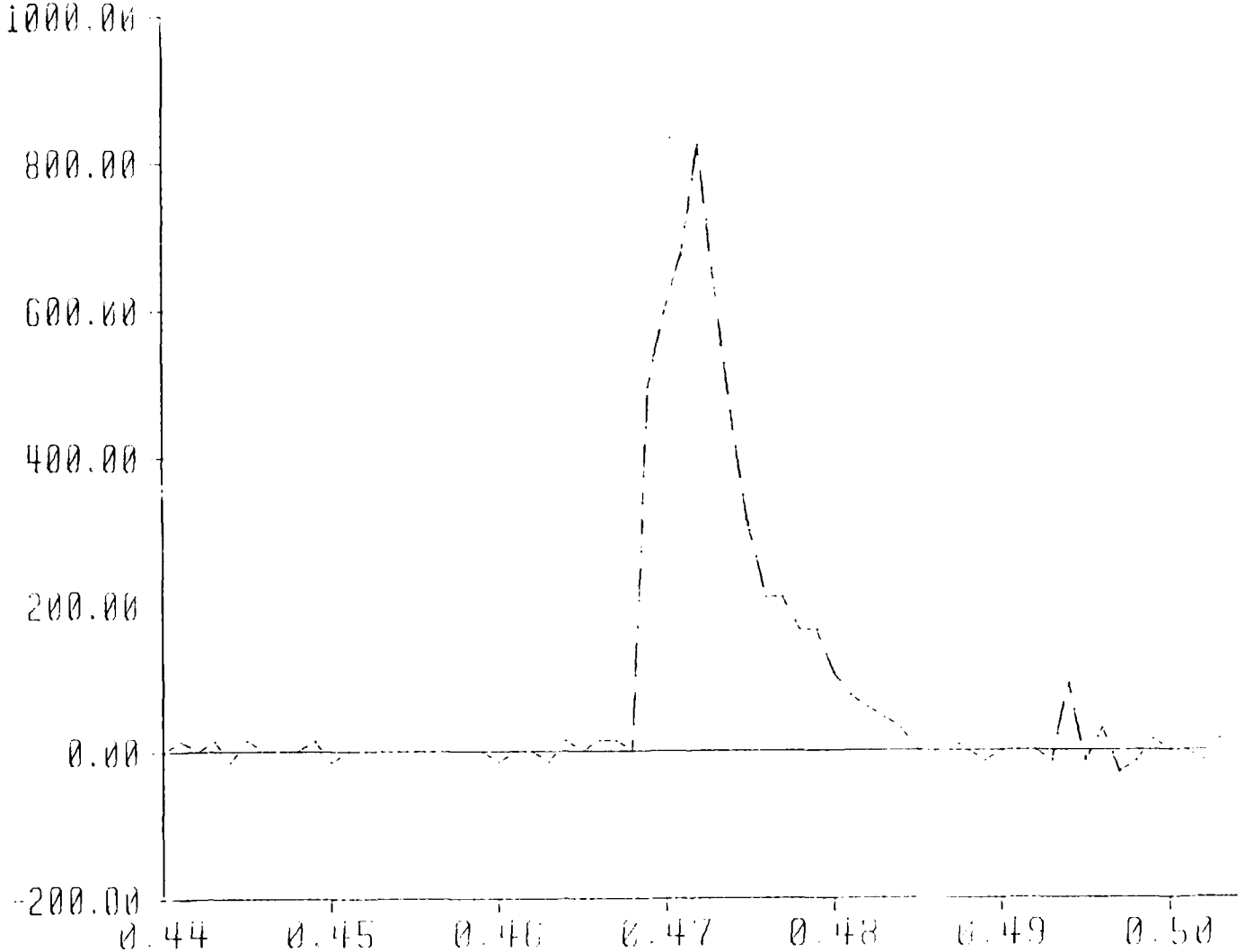
Graph 4 1: 6d Ring Shank

Sample 2



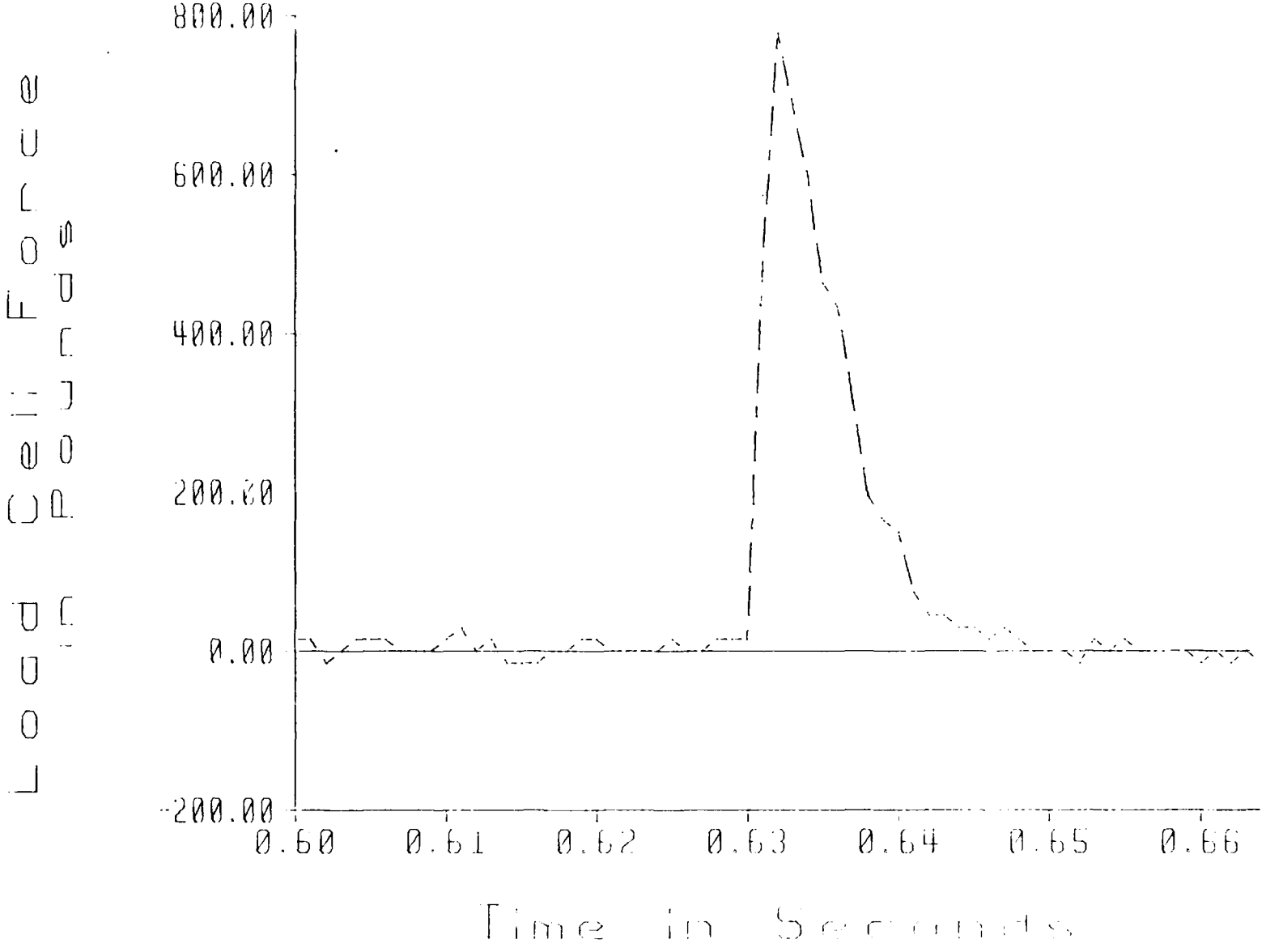
Graph 42: 6d Ring Shank

Sample 3



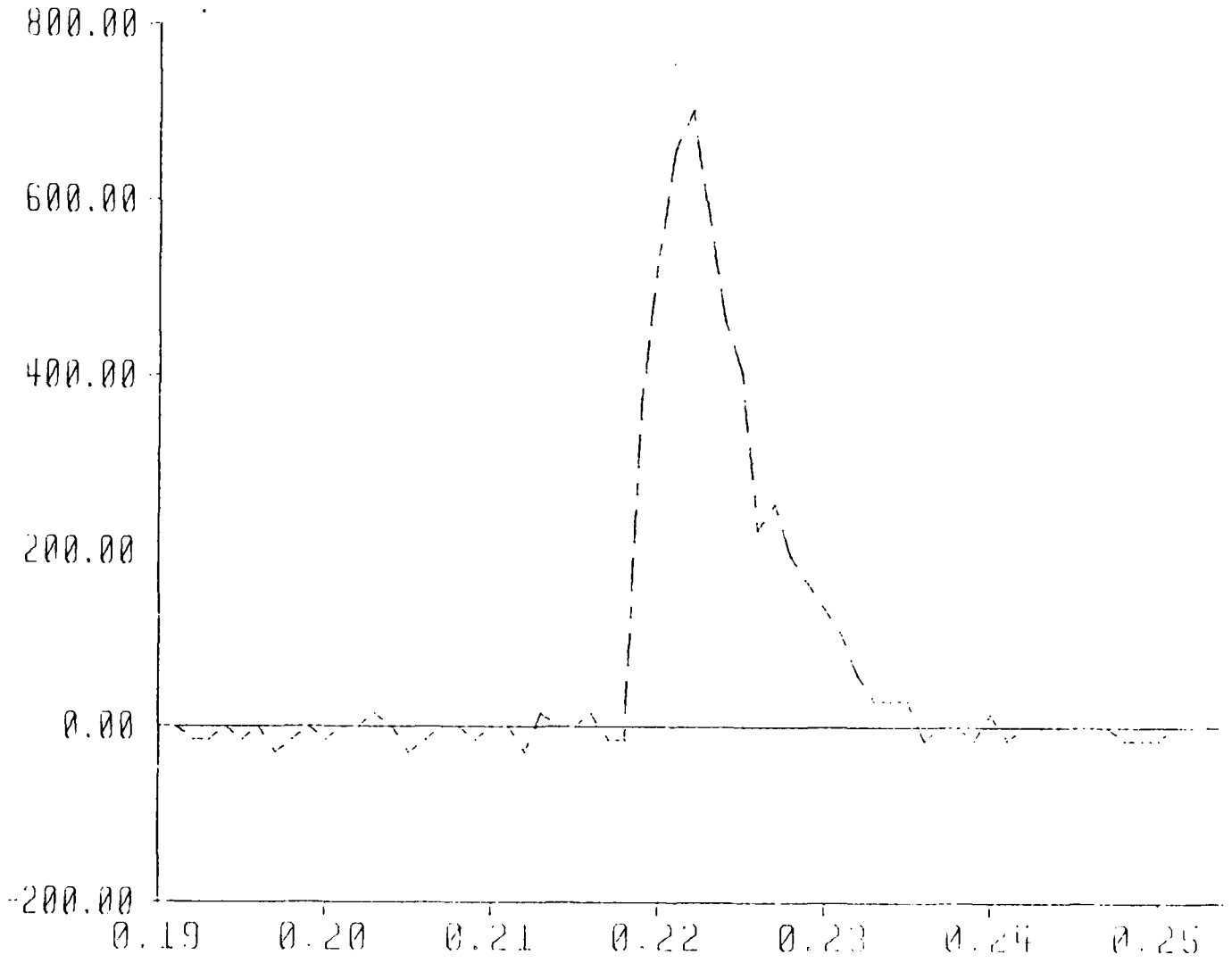
Graph 43: 6d Ring Shank

Sample 11



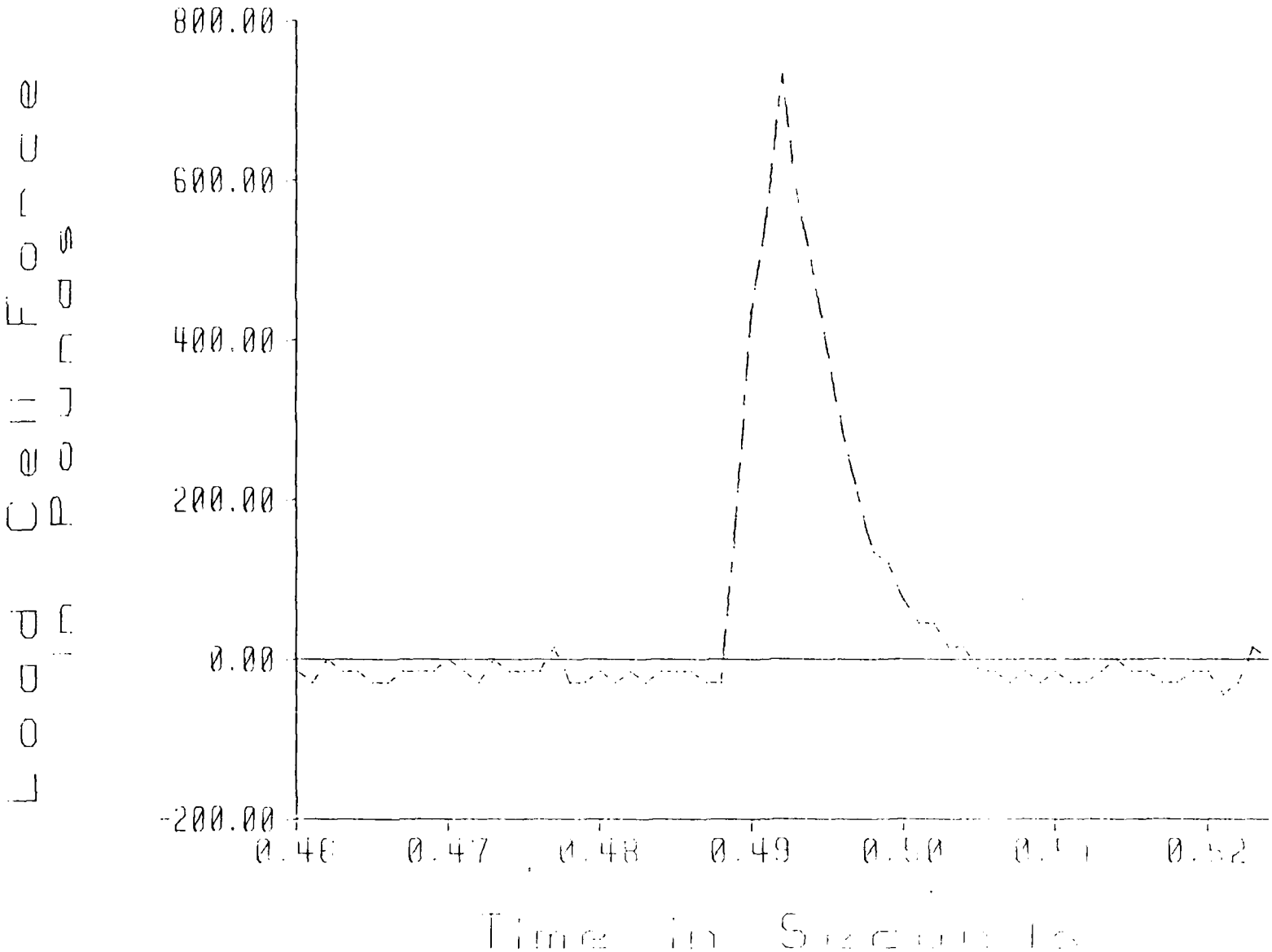
Graph 44: 6d Ring Shank

Sample 5

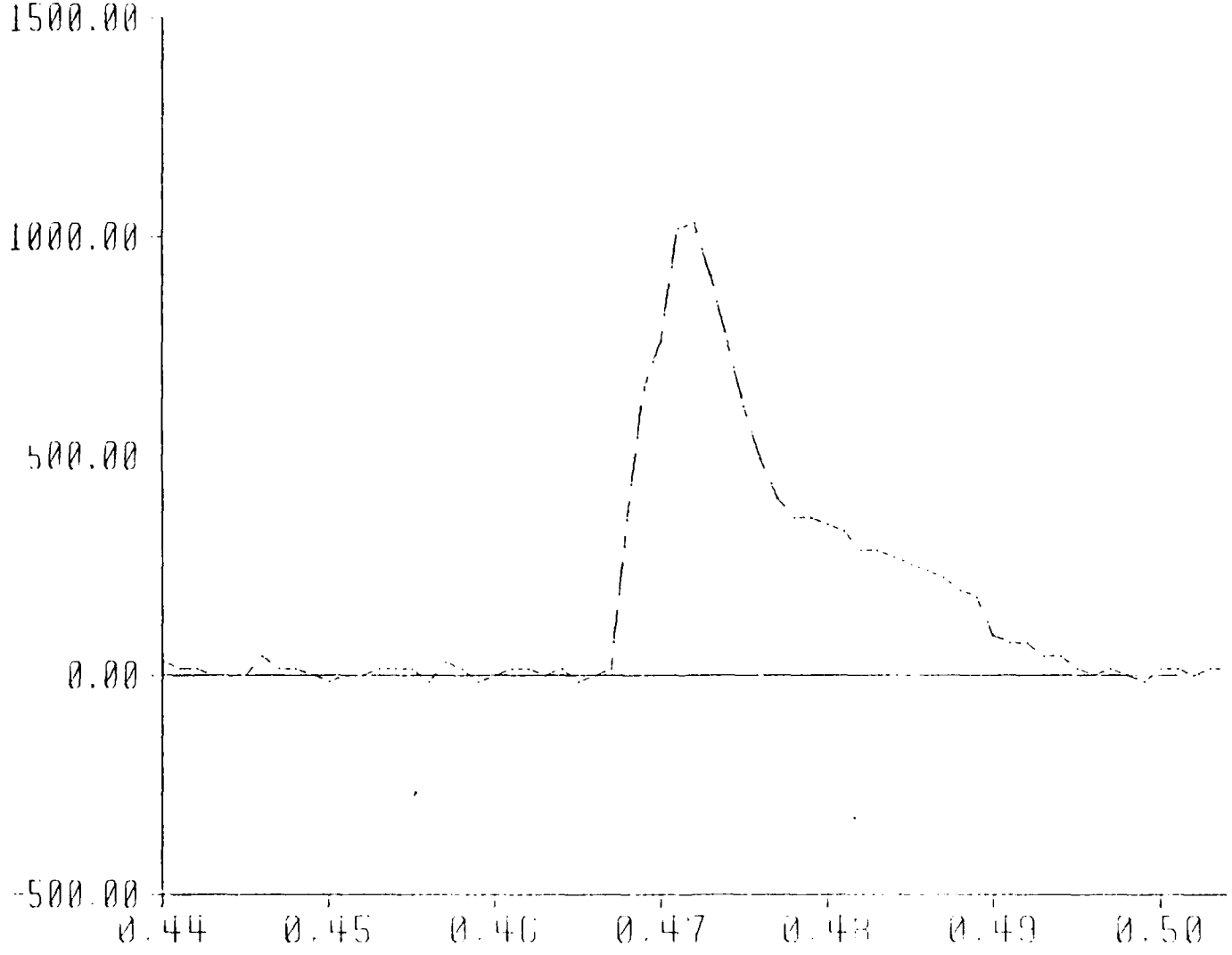


Graph 45: 6d Ring Shank

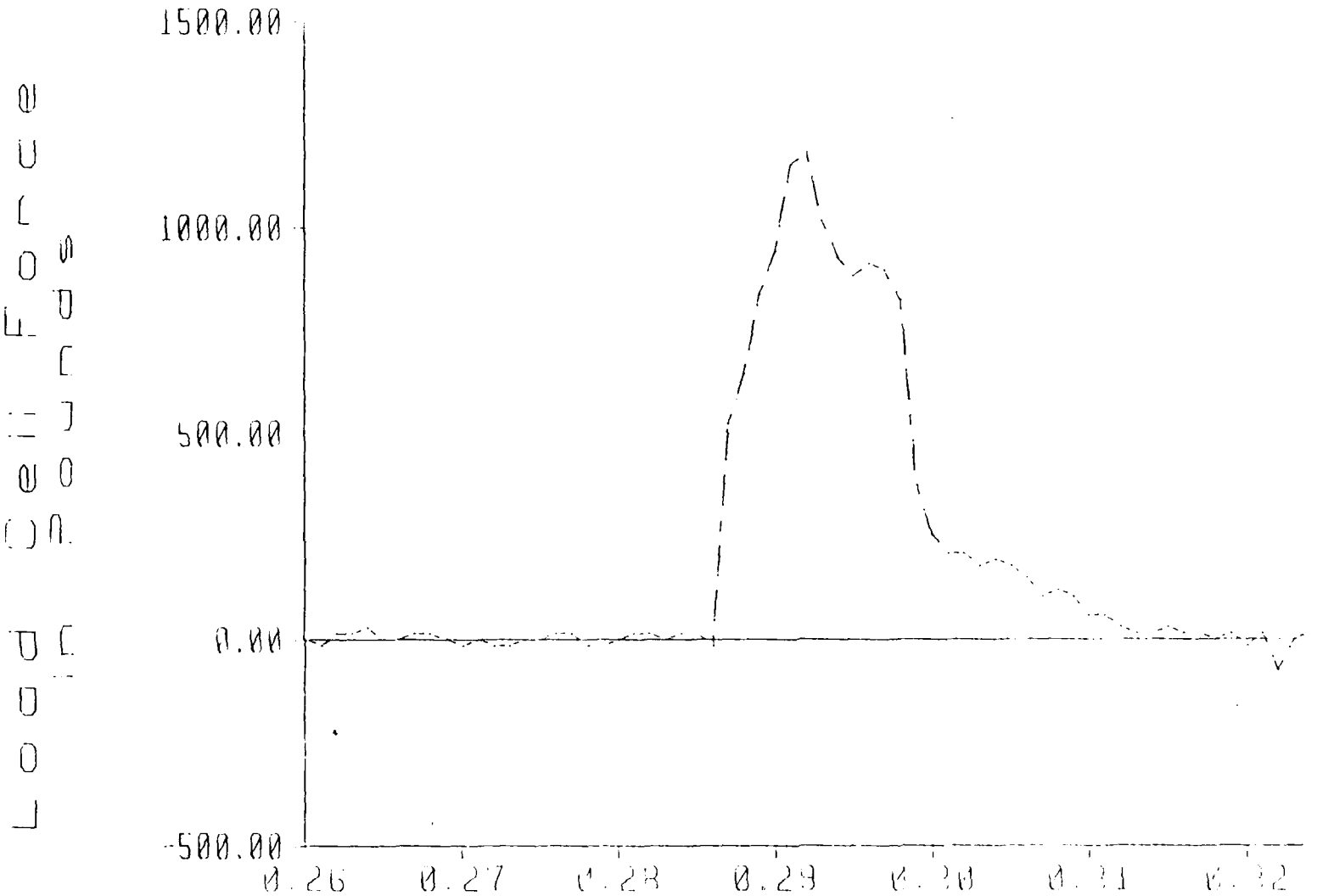
Sample 6



Graph 46: 8d Ring Shank
Sample 1

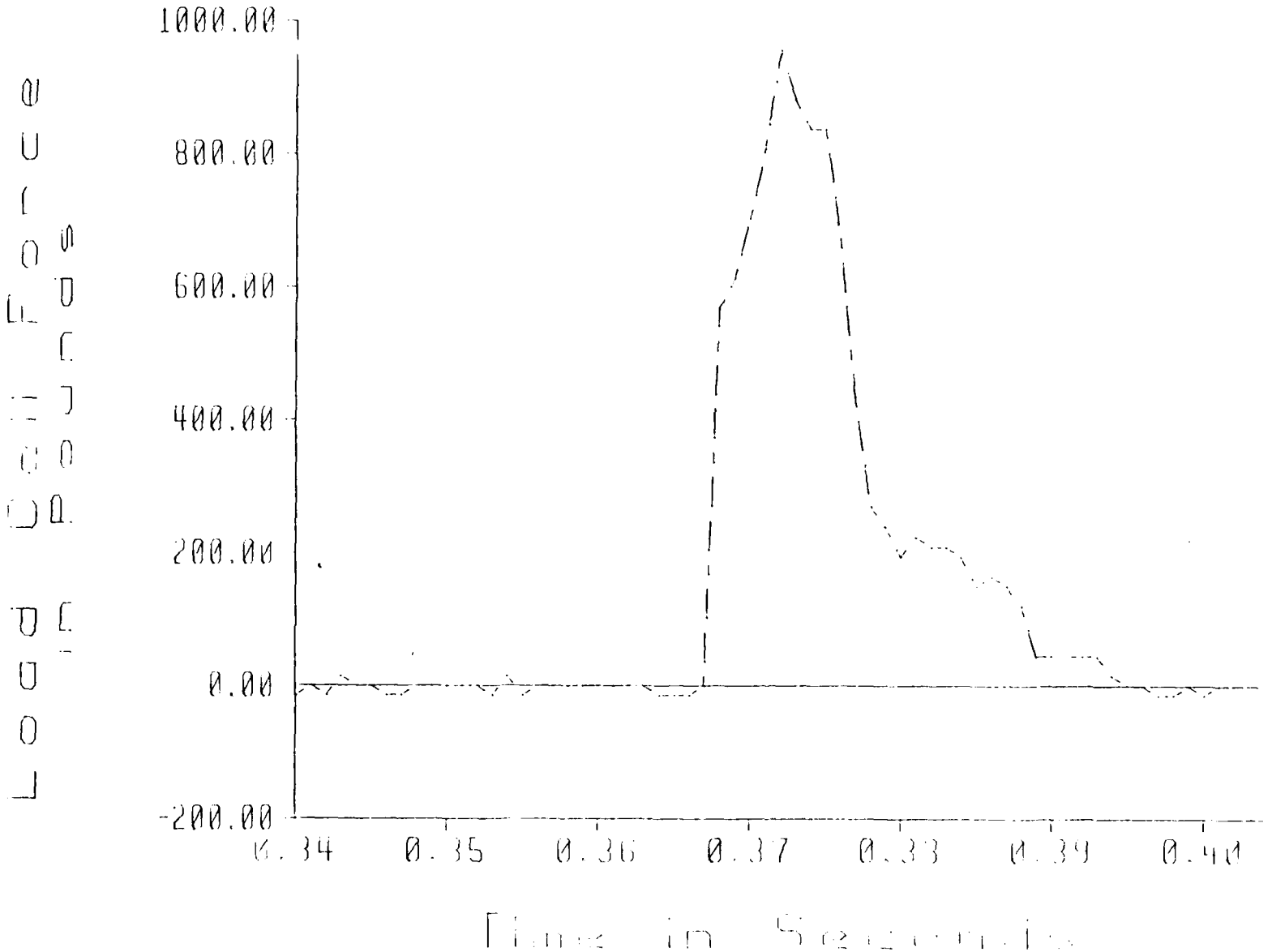


Graph 47: 8d Ring Shank
Sample 2



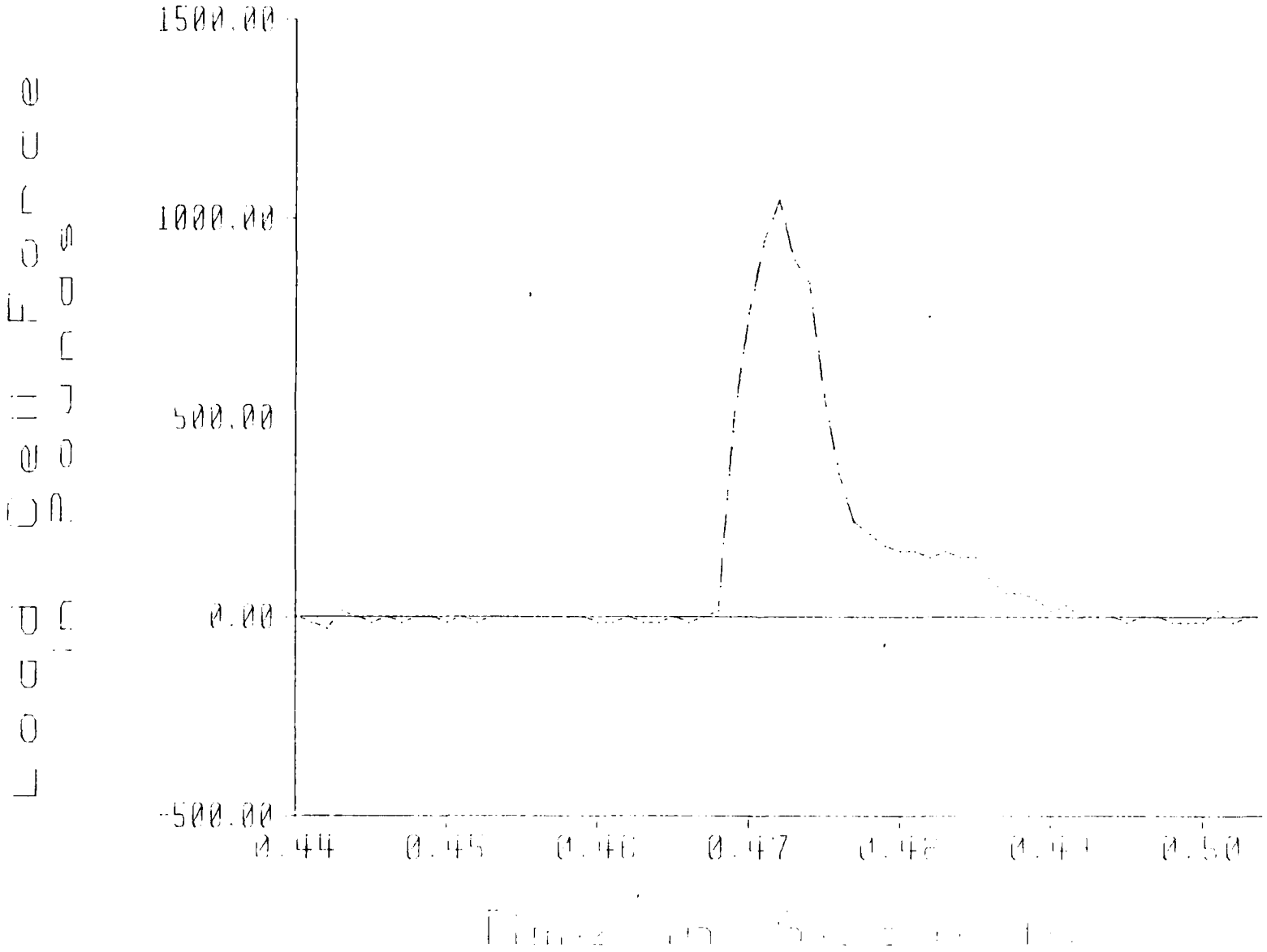
Graph 48: 8d Ring Shank

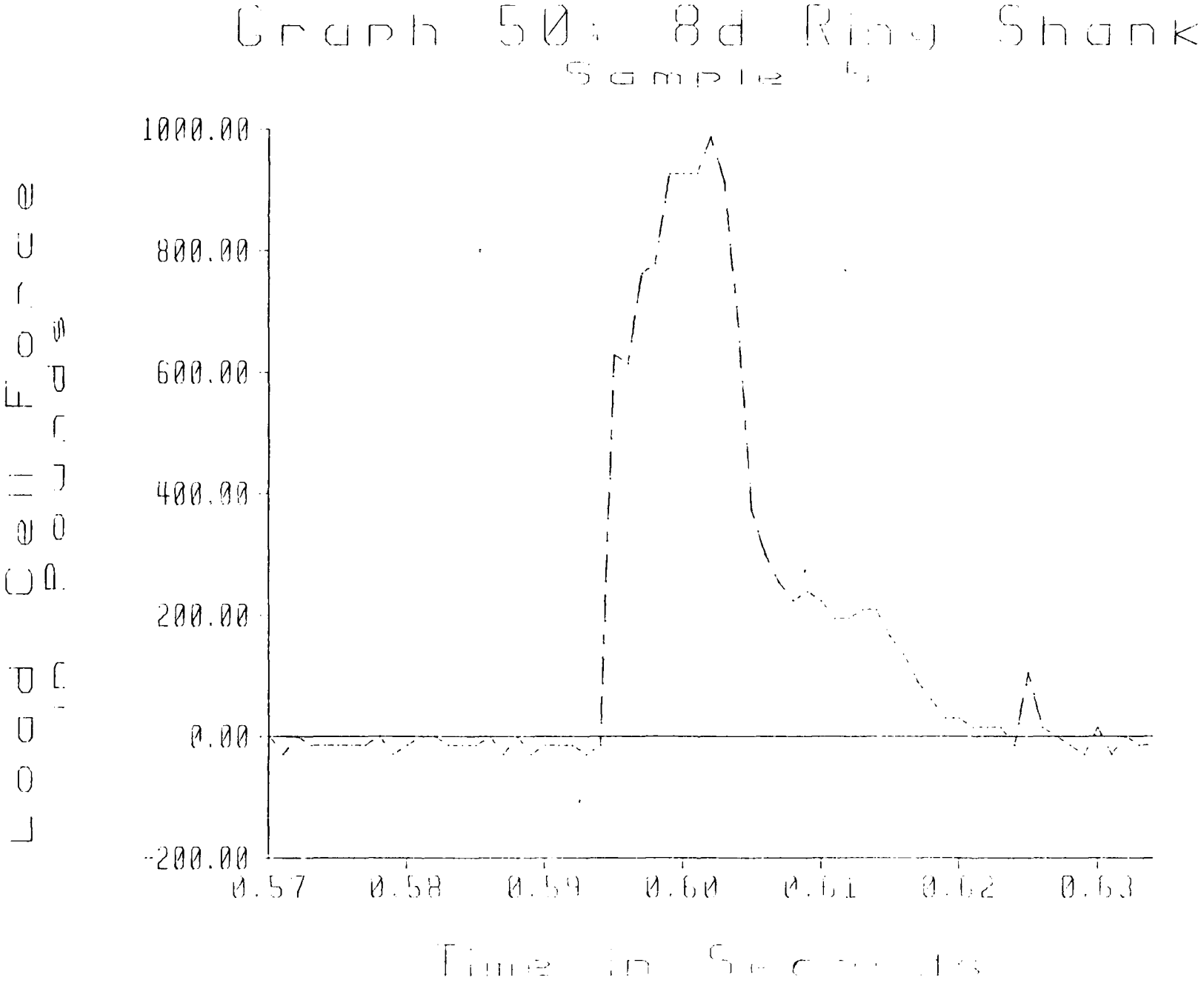
Sample 3

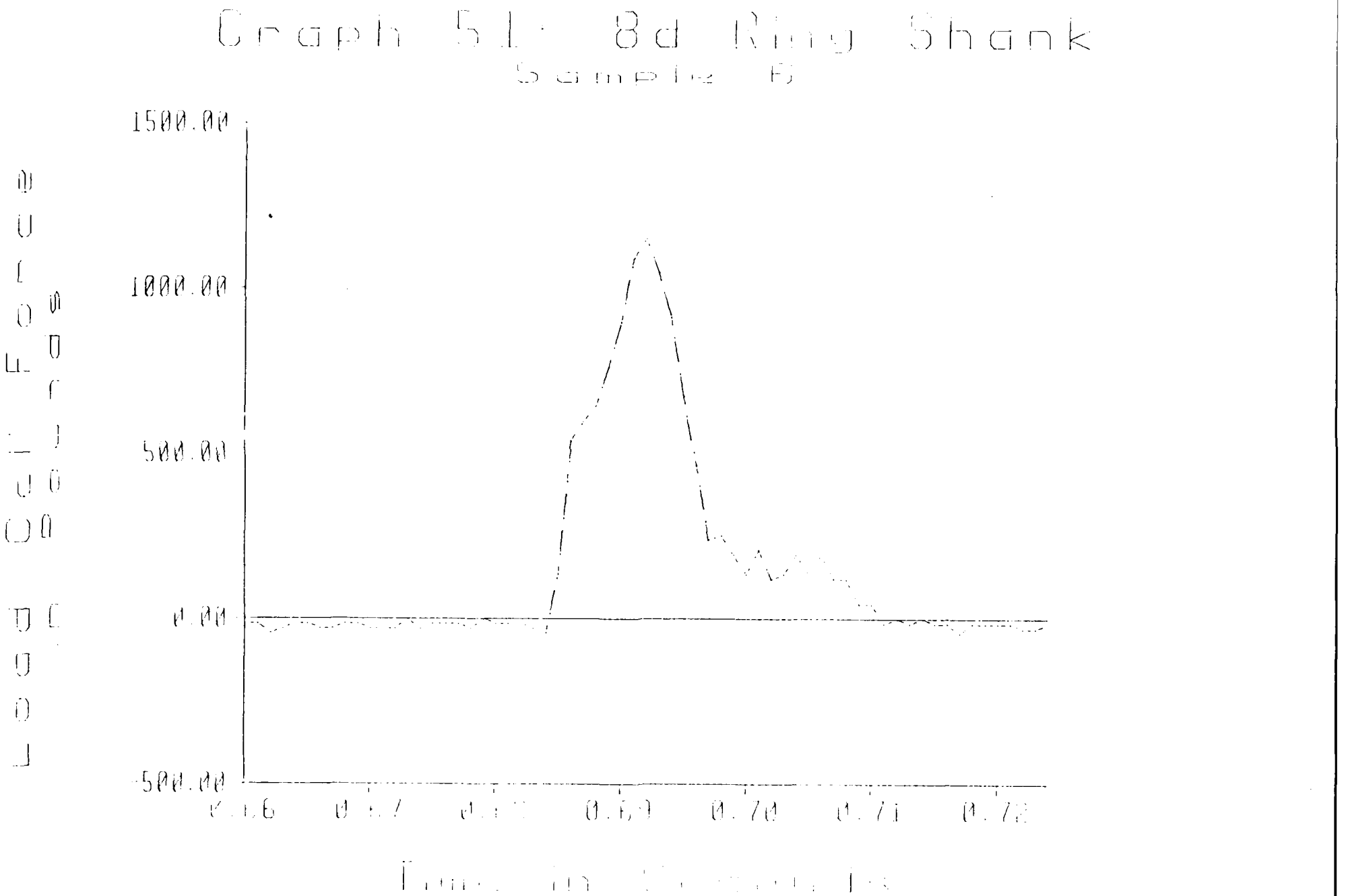


Graph 49: 8d Ring Shank

Sample 4




Graph 50: 8d Ring Shank
Sample 5
1000.00
800.00
600.00
400.00
200.00
0.00
-200.00
0.57
0.58
0.59
0.60
0.61
0.62
0.63


Graph 51: 8d Ring Shank
Sample 5
1500.00
1000.00
500.00
0.00
-500.00